OIPE JC184
NOV 10 2003
PATENT & TRADEMARK OFFICE

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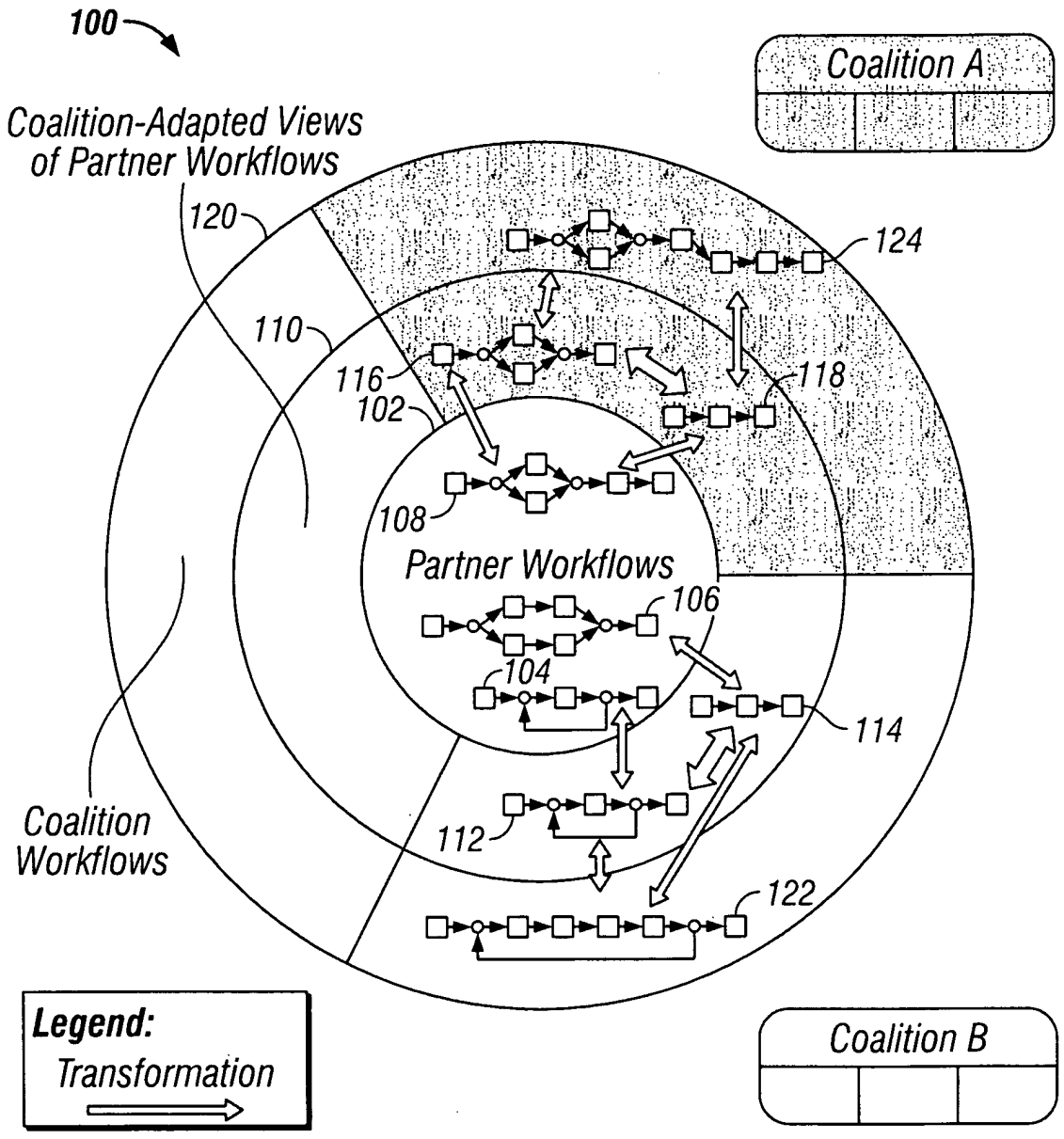

FIG. 1

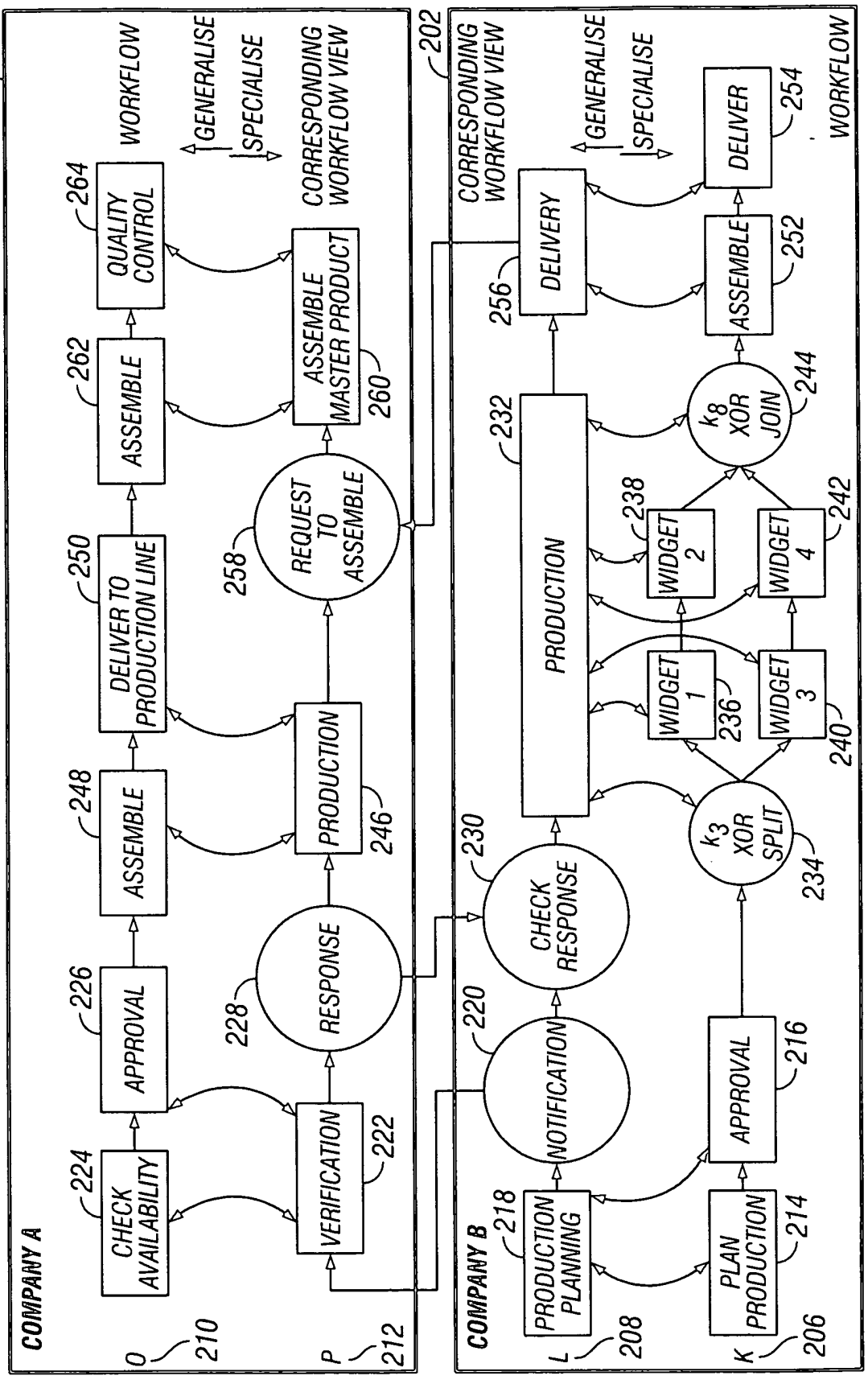
COMPANY A
COMPANY B
WORKFLOW
CORRESPONDING WORKFLOW VIEW
GENERALISE
SPECIALISE
CHECK AVAILABILITY
APPROVAL
ASSEMBLE
DELIVER TO PRODUCTION LINE
QUALITY CONTROL
ASSEMBLE
ASSEMBLE MASTER PRODUCT
VERIFICATION
RESPONSE
PRODUCTION
REQUEST TO ASSEMBLE
PRODUCTION PLANNING
NOTIFICATION
CHECK RESPONSE
PLAN PRODUCTION
APPROVAL
PRODUCTION
DELIVERY
WIDGET 1
WIDGET 2
WIDGET 3
WIDGET 4
k3 XOR SPLIT
k8 XOR JOIN
ASSEMBLE
DELIVER
0
P
L
K
204
202
210
212
208
206
224
226
248
250
262
264
260
258
222
228
246
218
220
214
216
230
232
256
236
238
240
242
234
244
252
254

FIG. 2

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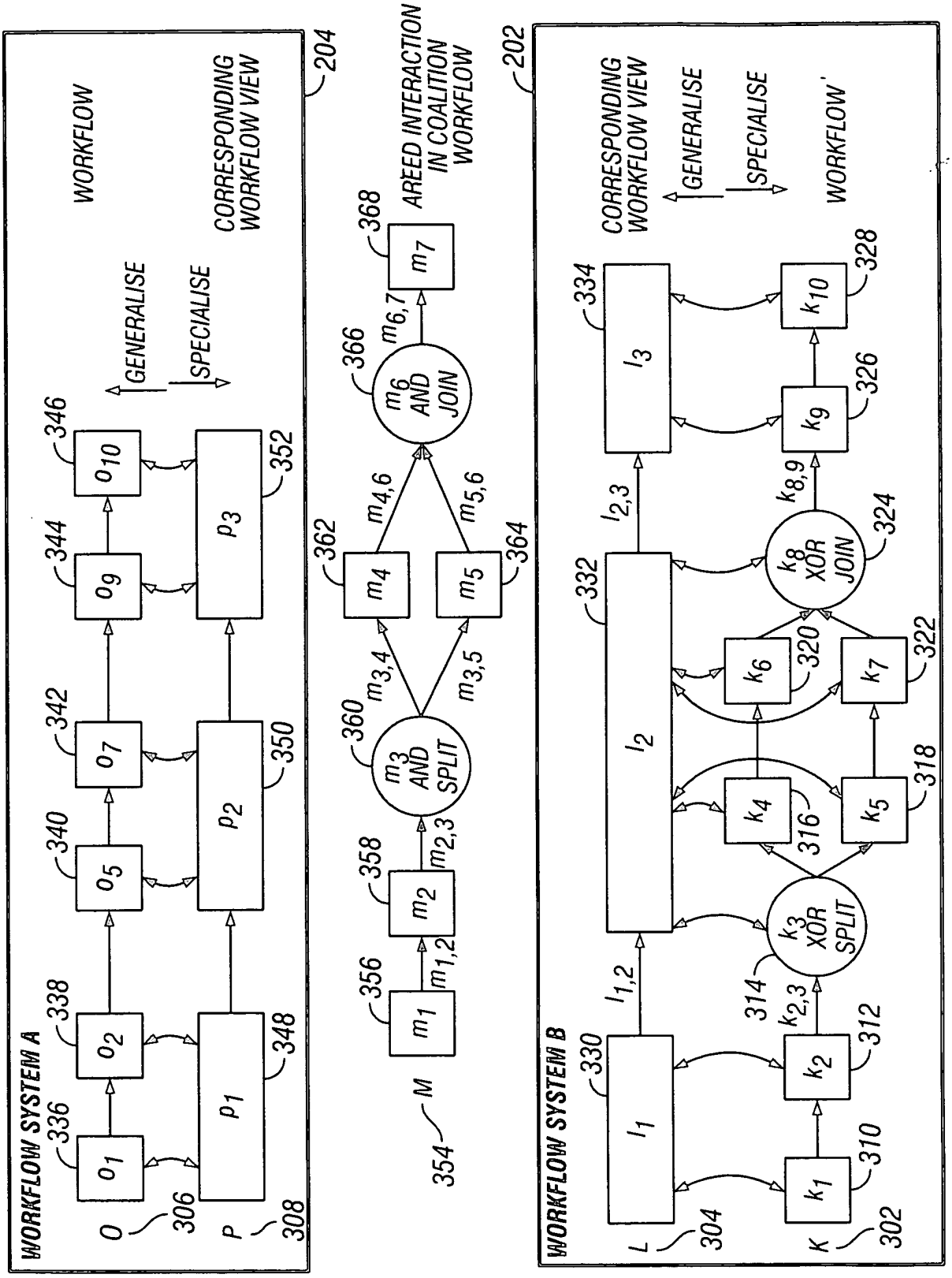
WORKFLOW SYSTEM A
WORKFLOW
CORRESPONDING WORKFLOW VIEW
GENERALISE
SPECIALISE
AREED INTERACTION IN COALITION WORKFLOW
WORKFLOW SYSTEM B
WORKFLOW'
CORRESPONDING WORKFLOW VIEW
GENERALISE
SPECIALISE
AND SPLIT
AND JOIN
XOR SPLIT
XOR JOIN

FIG. 3

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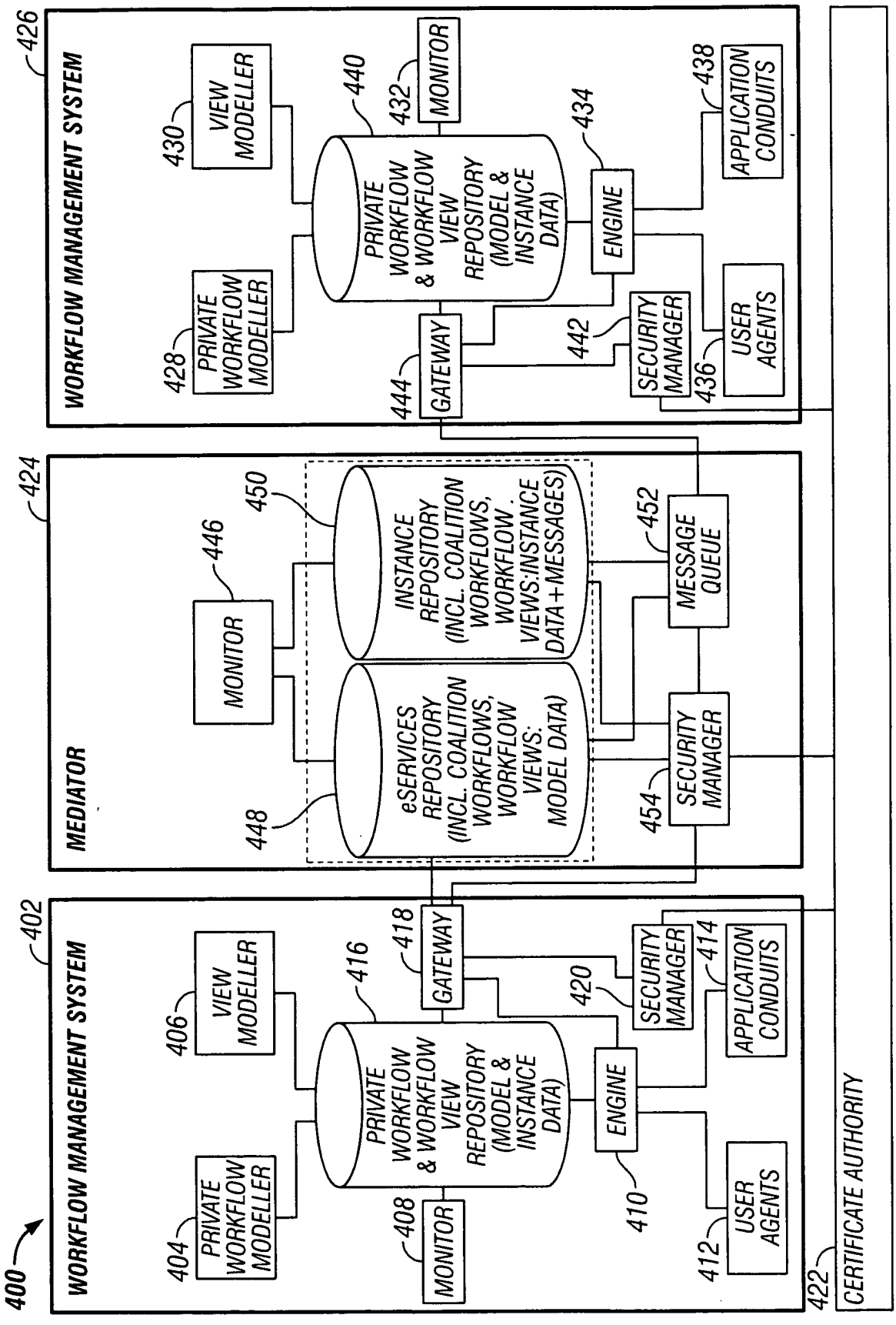
400
WORKFLOW MANAGEMENT SYSTEM
402
PRIVATE WORKFLOW MODELLER
404
VIEW MODELLER
406
MONITOR
408
PRIVATE WORKFLOW & WORKFLOW VIEW REPOSITORY (MODEL & INSTANCE DATA)
416
ENGINE
410
USER AGENTS
412
GATEWAY
418
SECURITY MANAGER
420
APPLICATION CONDUITS
414
MEDIATOR
424
eSERVICES REPOSITORY (INCL. COALITION WORKFLOWS, WORKFLOW VIEWS: MODEL DATA)
448
INSTANCE REPOSITORY (INCL. COALITION WORKFLOWS, WORKFLOW VIEWS: INSTANCE DATA + MESSAGES)
450
MONITOR
446
SECURITY MANAGER
454
MESSAGE QUEUE
452
WORKFLOW MANAGEMENT SYSTEM
426
PRIVATE WORKFLOW MODELLER
428
VIEW MODELLER
430
MONITOR
432
PRIVATE WORKFLOW & WORKFLOW VIEW REPOSITORY (MODEL & INSTANCE DATA)
440
ENGINE
434
APPLICATION CONDUITS
438
GATEWAY
444
SECURITY MANAGER
442
USER AGENTS
436
CERTIFICATE AUTHORITY
422

FIG. 4

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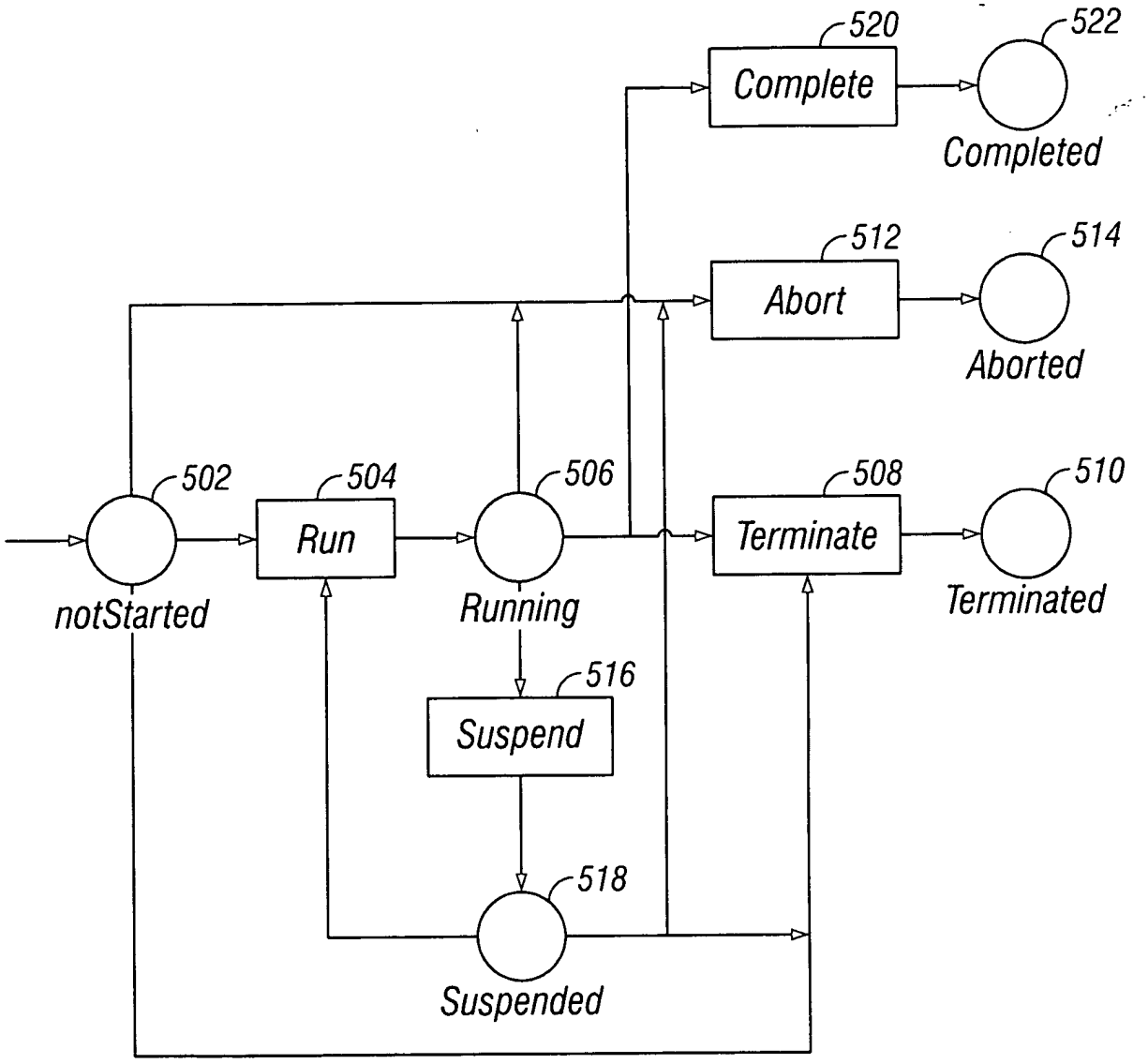
520
Complete
522
Completed
512
Abort
514
Aborted
502
notStarted
504
Run
506
Running
508
Terminate
510
Terminated
516
Suspend
518
Suspended

FIG. 5

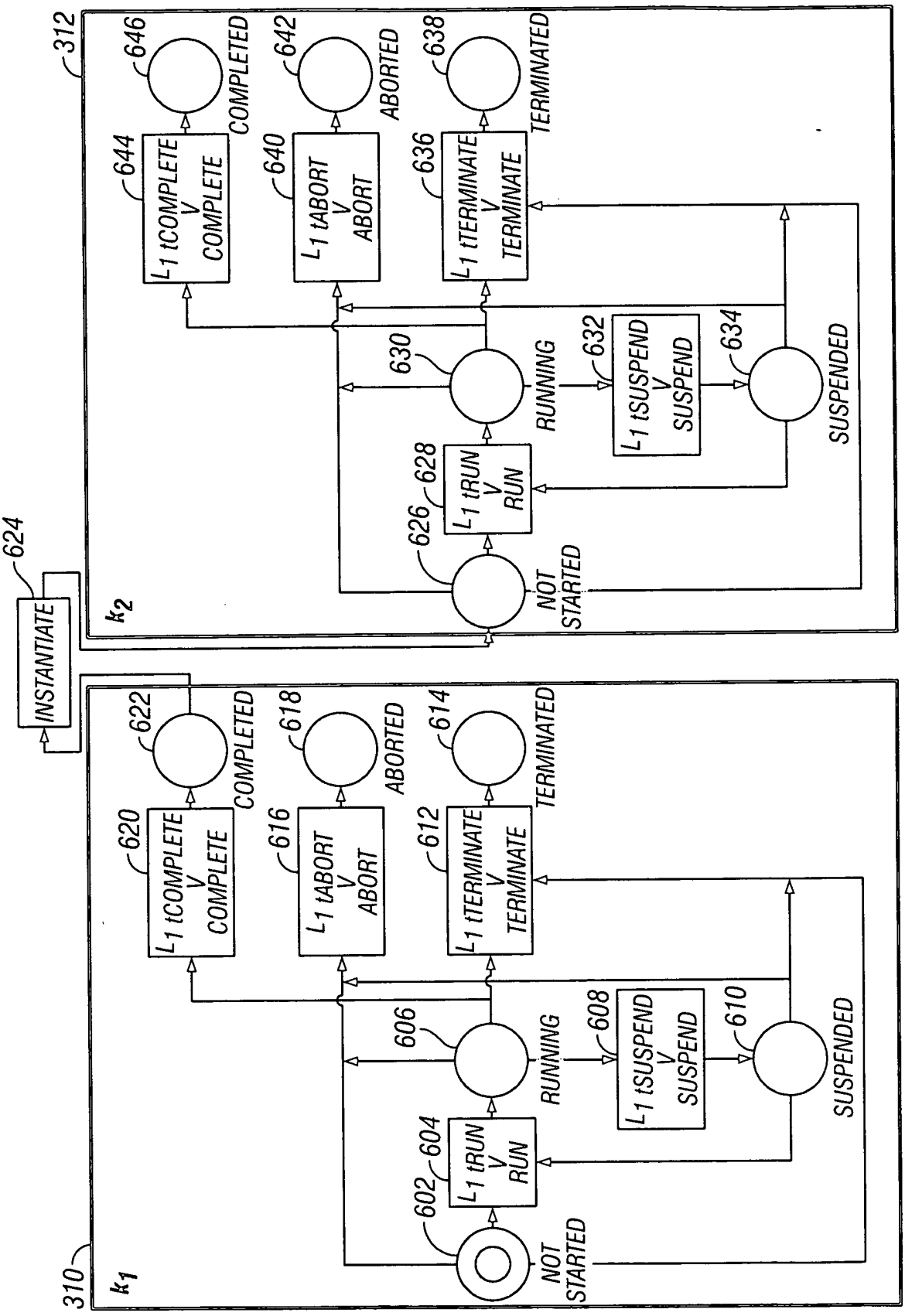
310
K1
NOT STARTED
602
L1 tRUN V RUN
604
RUNNING
606
L1 tSUSPEND V SUSPEND
608
SUSPENDED
610
L1 tTERMINATE V TERMINATE
612
TERMINATED
614
L1 tABORT V ABORT
616
ABORTED
618
L1 tCOMPLETE V COMPLETE
620
COMPLETED
622
INSTANTIATE
624
312
K2
NOT STARTED
626
L1 tRUN V RUN
628
RUNNING
630
L1 tSUSPEND V SUSPEND
632
SUSPENDED
634
L1 tTERMINATE V TERMINATE
636
TERMINATED
638
L1 tABORT V ABORT
640
ABORTED
642
L1 tCOMPLETE V COMPLETE
644
COMPLETED
646

FIG. 6

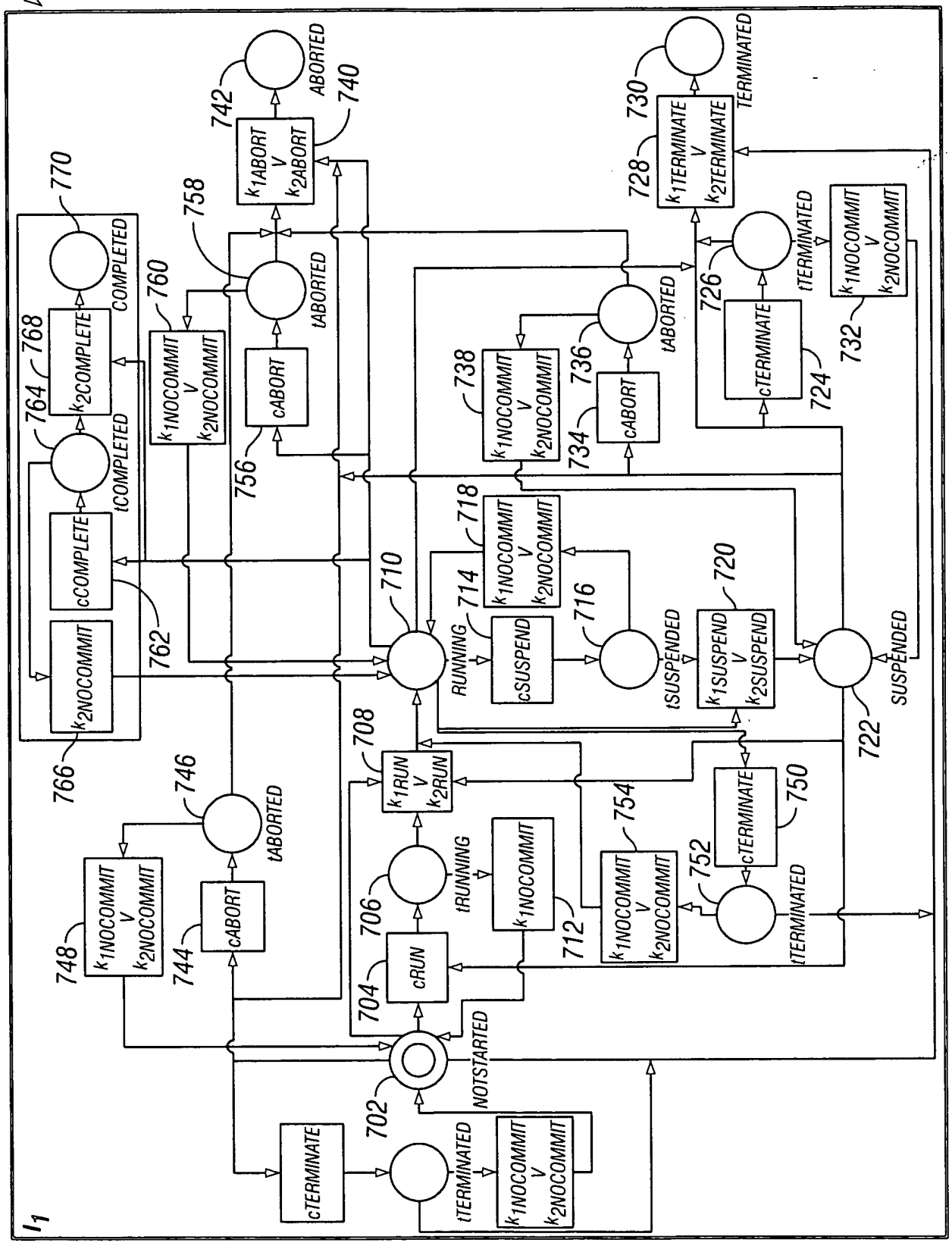
330
I1
NOTSTARTED
RUNNING
SUSPENDED
ABORTED
TERMINATED
COMPLETED
tRUNNING
tSUSPENDED
tABORTED
tTERMINATED
tCOMPLETED
cRUN
cSUSPEND
cABORT
cTERMINATE
cCOMPLETE
k1RUN V k2RUN
k1SUSPEND V k2SUSPEND
k1ABORT V k2ABORT
k1TERMINATE V k2TERMINATE
k1COMMIT V k2COMMIT
k2COMPLETE
k2NOCOMMIT
702
704
706
708
710
712
714
716
718
720
722
724
726
728
730
732
734
736
738
740
742
744
746
748
750
752
754
756
758
760
762
764
766
768
770

FIG. 7

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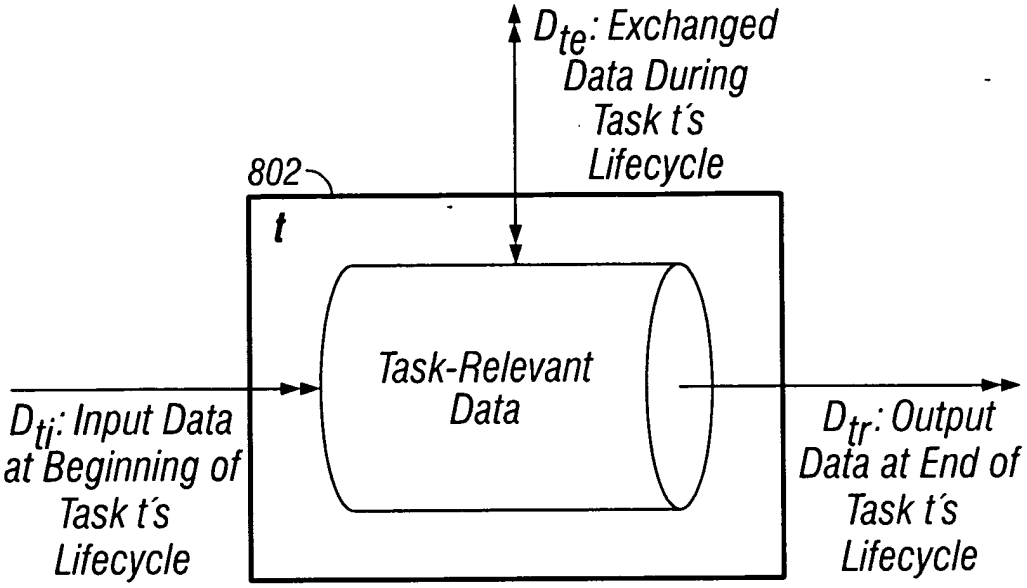

FIG. 8

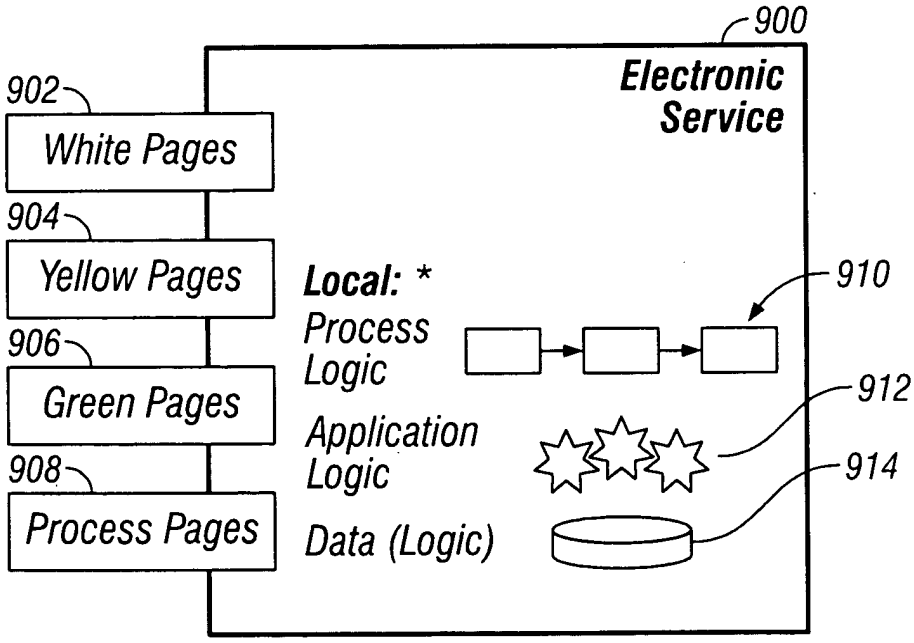

FIG. 9

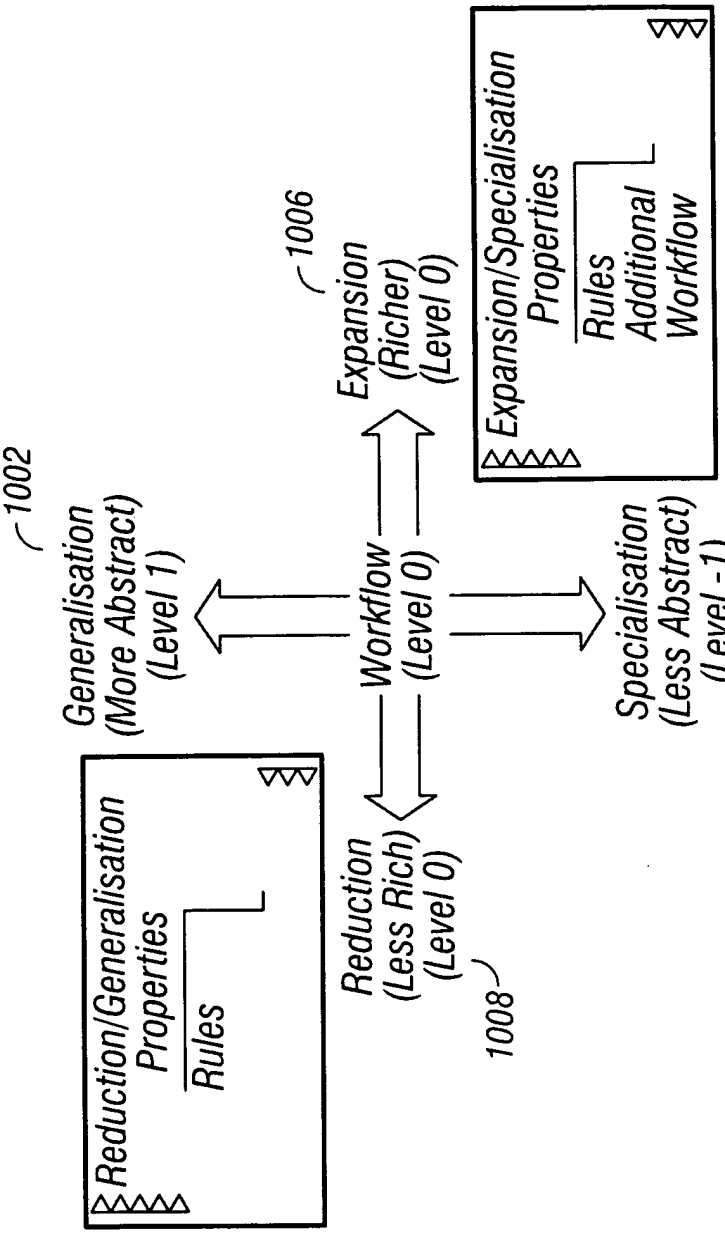
1002
Generalisation
(More Abstract)
(Level 1)
1006
Expansion
(Richer)
(Level 0)
Expansion/Specialisation
Properties
Rules
Additional
Workflow
Workflow
(Level 0)
Specialisation
(Less Abstract)
(Level -1)
1004
Reduction/Generalisation
Properties
Rules
Reduction
(Less Rich)
(Level 0)
1008

FIG. 10

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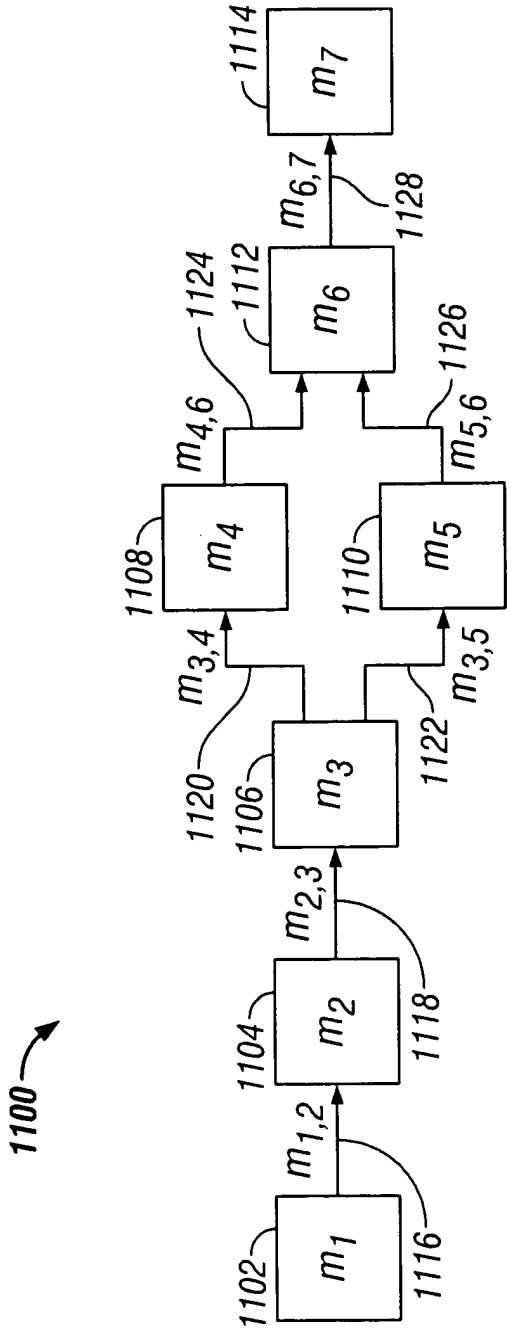
1100
1102
m_1
1116
$m_{1,2}$
1104
m_2
1118
$m_{2,3}$
1106
m_3
1120
1122
$m_{3,4}$
$m_{3,5}$
1108
m_4
1110
m_5
1124
1126
$m_{4,6}$
$m_{5,6}$
1112
m_6
1128
$m_{6,7}$
1114
m_7

FIG. 11

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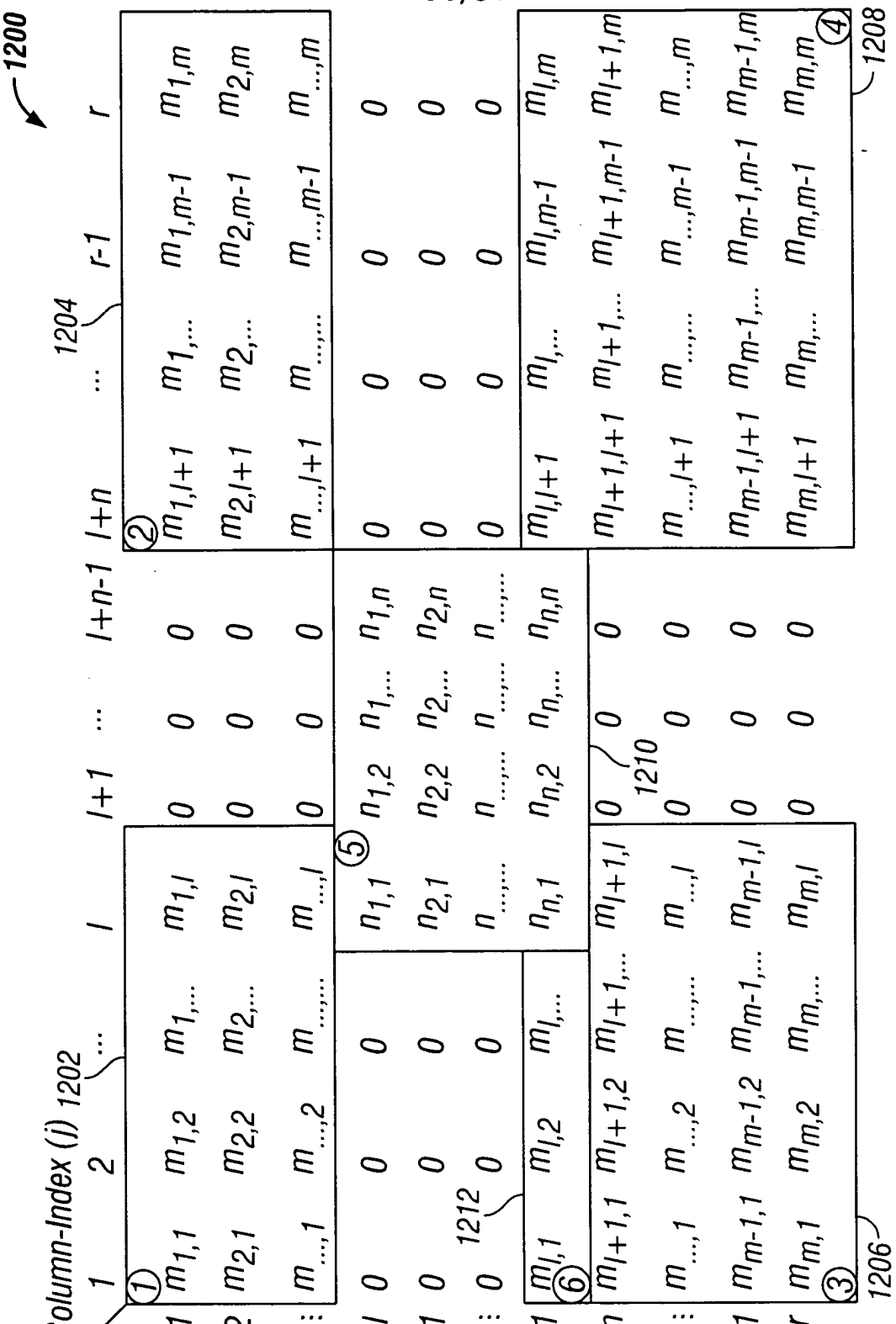
1200
Column-Index (j)
Row-Index (i)
1202
1204
1206
1208
1210
1212
1
2
...
l
l+1
l+n-1
l+n
r-1
r

FIG. 12

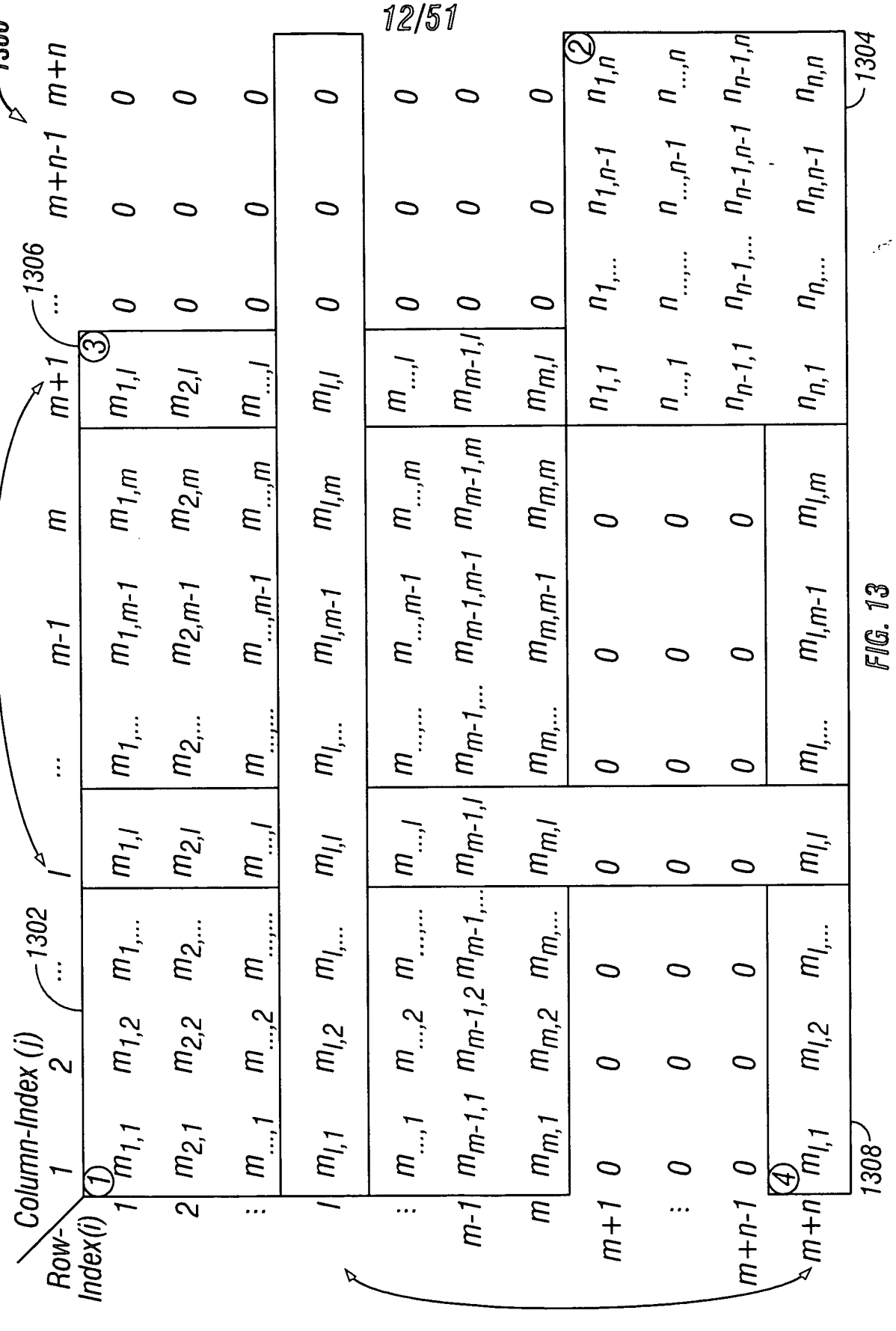
1300
1302
1304
1306
1308
Column-Index (j)
Row-Index(i)
1
2
...
l
m-1
m
m+1
m+n-1
m+n
①
②
③
④

FIG. 13

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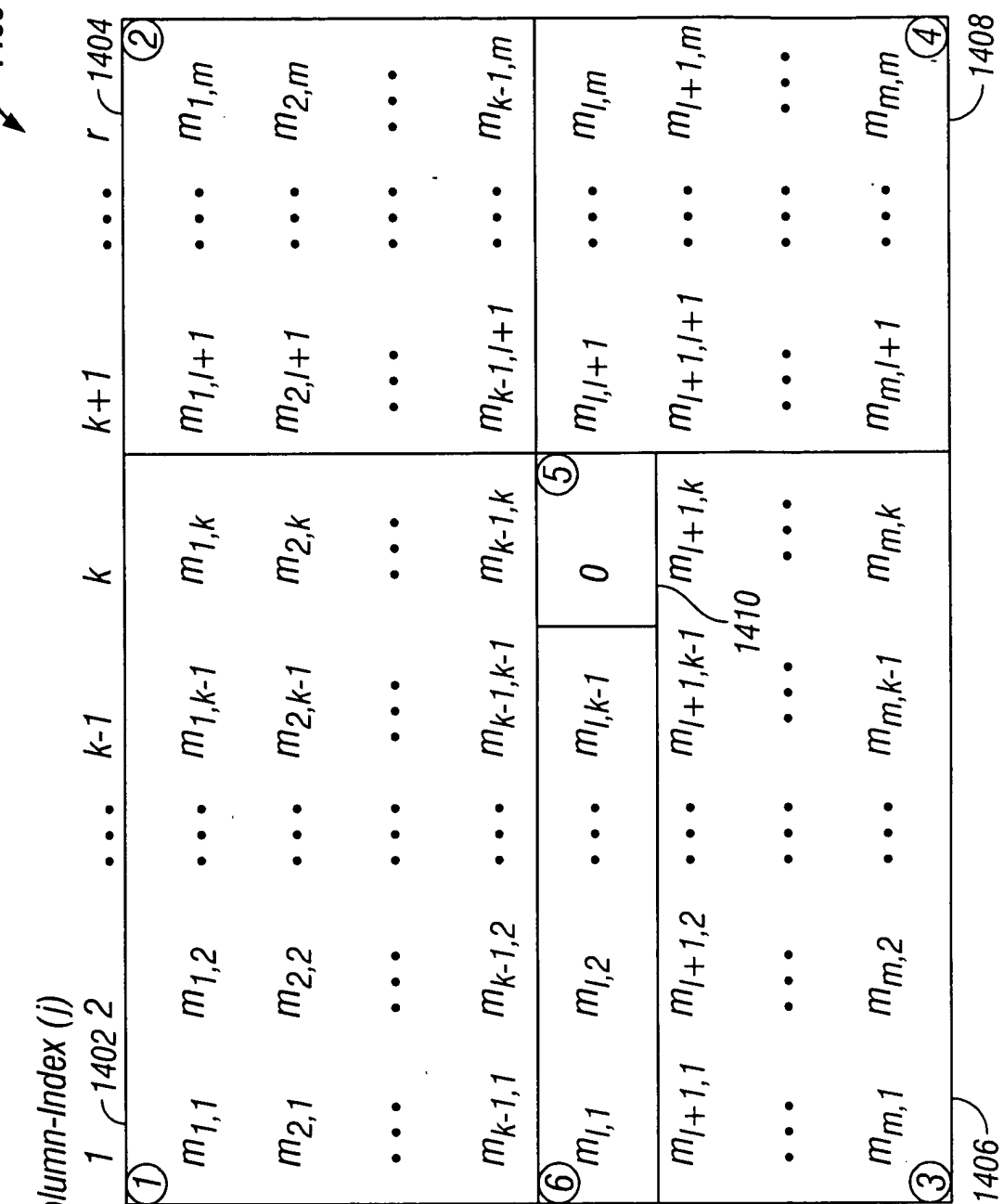
1400
Column-Index (j)
Row-Index (i)
1
2
k-1
k
k+1
r
1402
1404
1406
1408
1410
1412
1
2
3
4
5
6

FIG. 14

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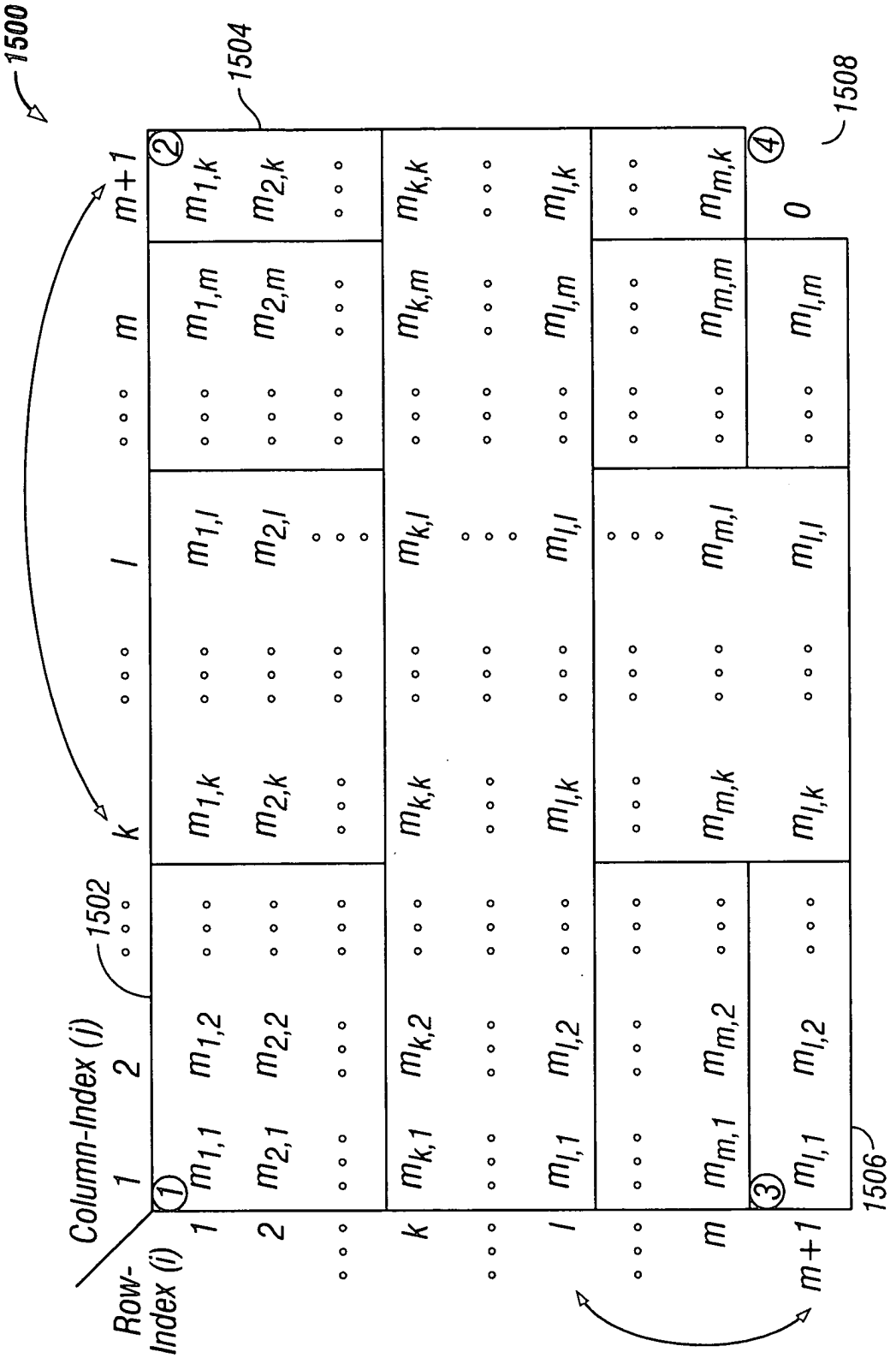
1500
1502
1504
1506
1508
Column-Index (j)
Row-Index (i)
1
2
k
l
m
m+1
0
①
②
③
④

FIG. 15

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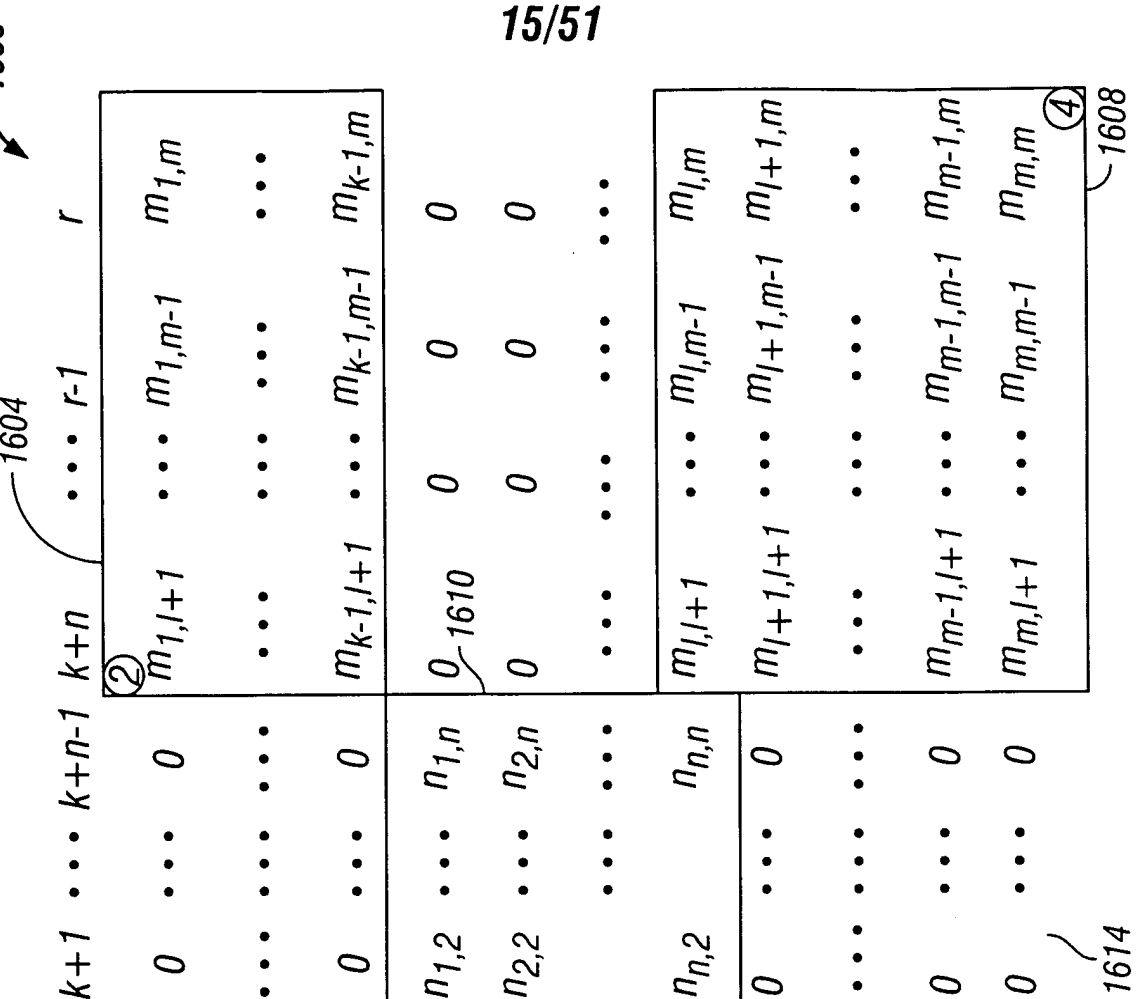
1600
Column-Index (j)
Row-Index (i)
1602
1604
1606
1608
1610
1612
1614
1
k-1
k
k+1
k+n-1
k+n
r-1
r
1
2
3
4
5
6

FIG. 16

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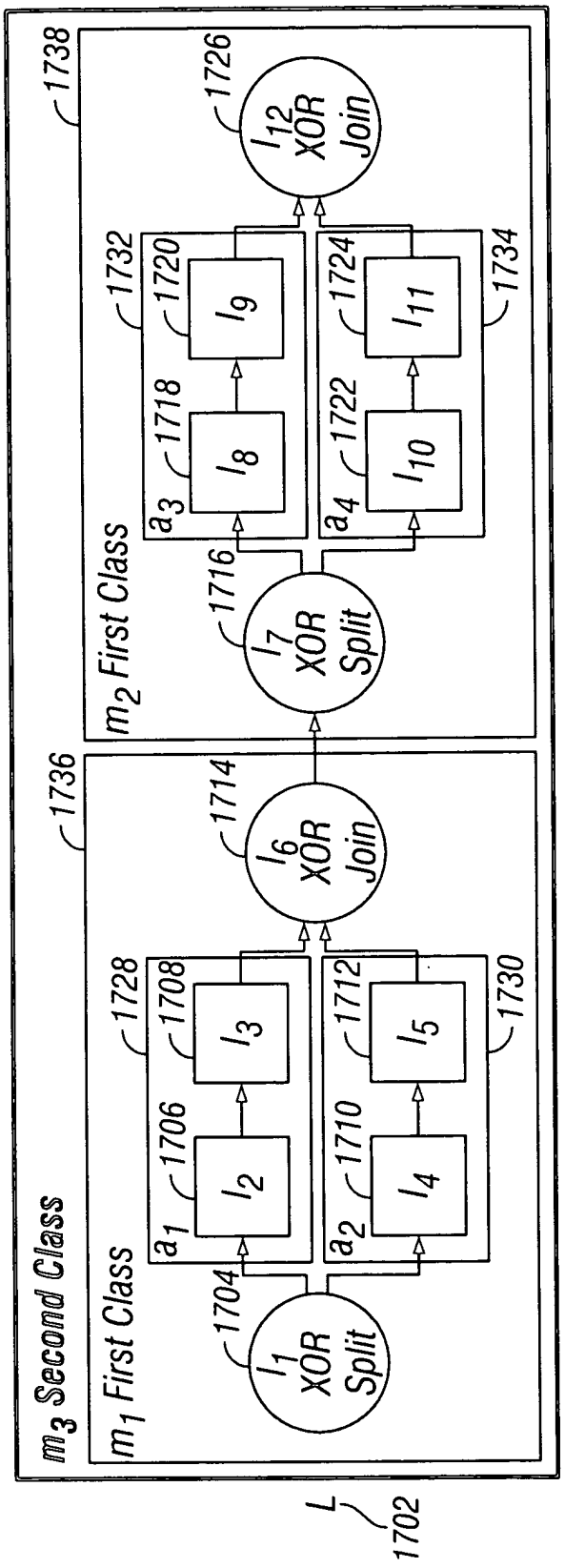

FIG. 17

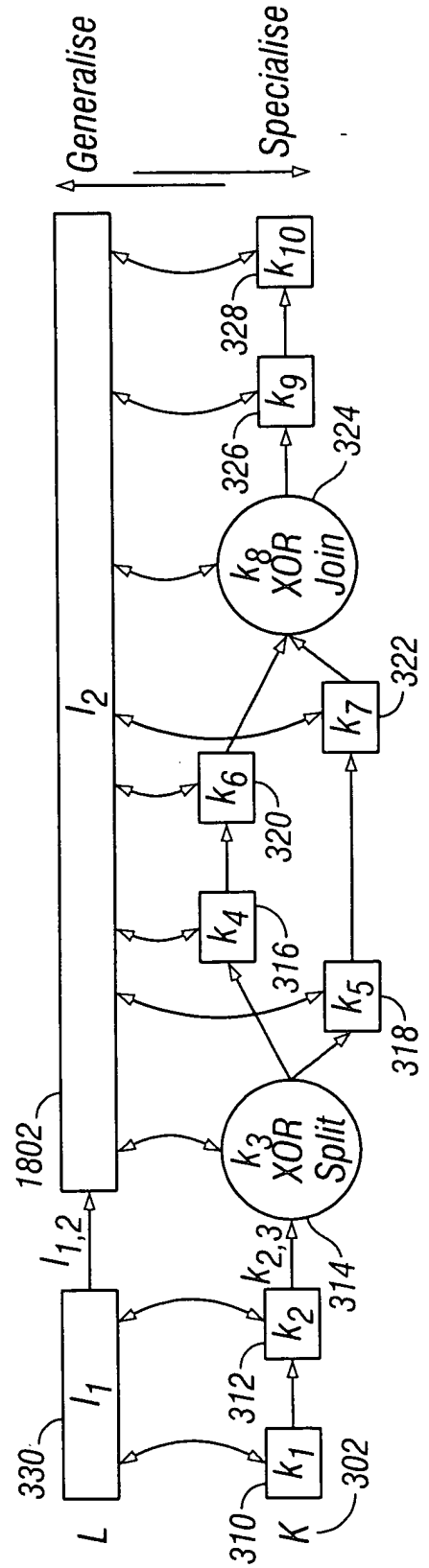

FIG. 18

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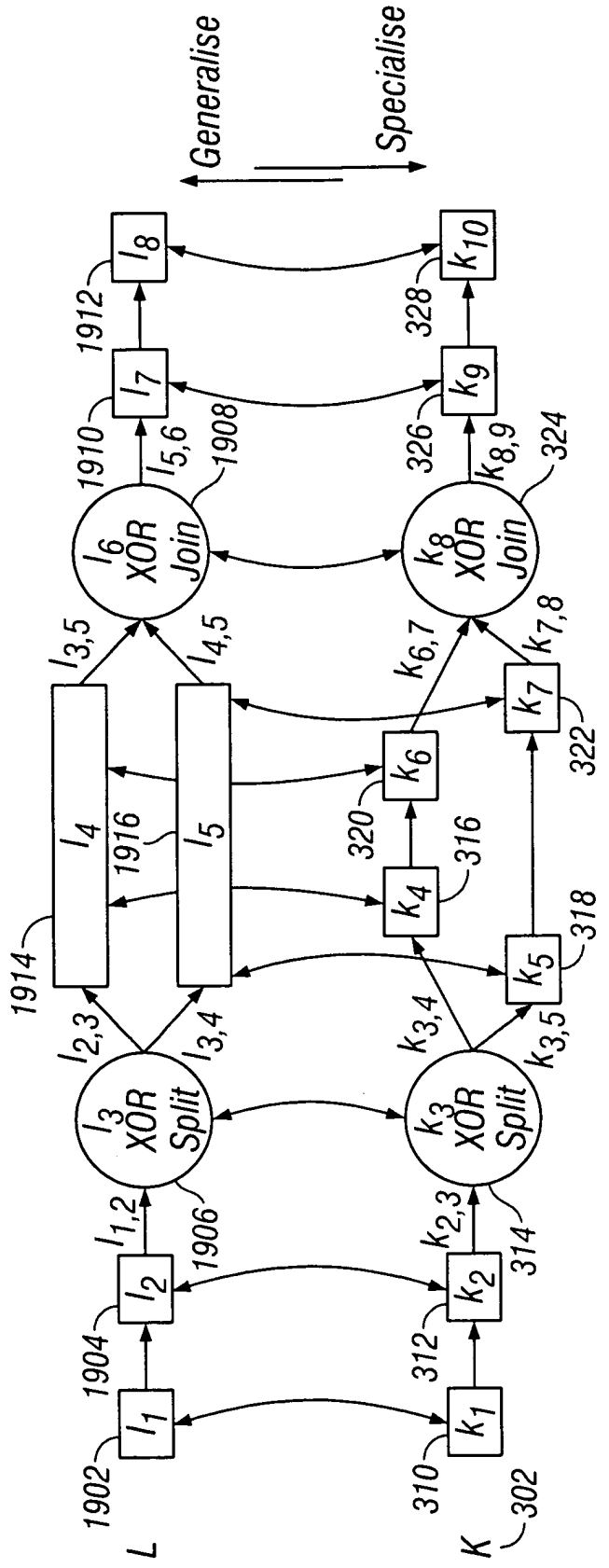
Generalise
Specialise
L
K
1902
1904
1906
1908
1910
1912
1914
1916
302
310
312
314
316
318
320
322
324
326
328
l_1
l_2
l_3 XOR Split
l_4
l_5
l_6 XOR Join
l_7
l_8
k_1
k_2
k_3 XOR Split
k_4
k_5
k_6
k_7
k_8 XOR Join
k_9
k_{10}
$l_{1,2}$
$l_{2,3}$
$l_{3,4}$
$l_{3,5}$
$l_{4,5}$
$l_{5,6}$
$k_{2,3}$
$k_{3,4}$
$k_{3,5}$
$k_{6,7}$
$k_{7,8}$
$k_{8,9}$

FIG. 19

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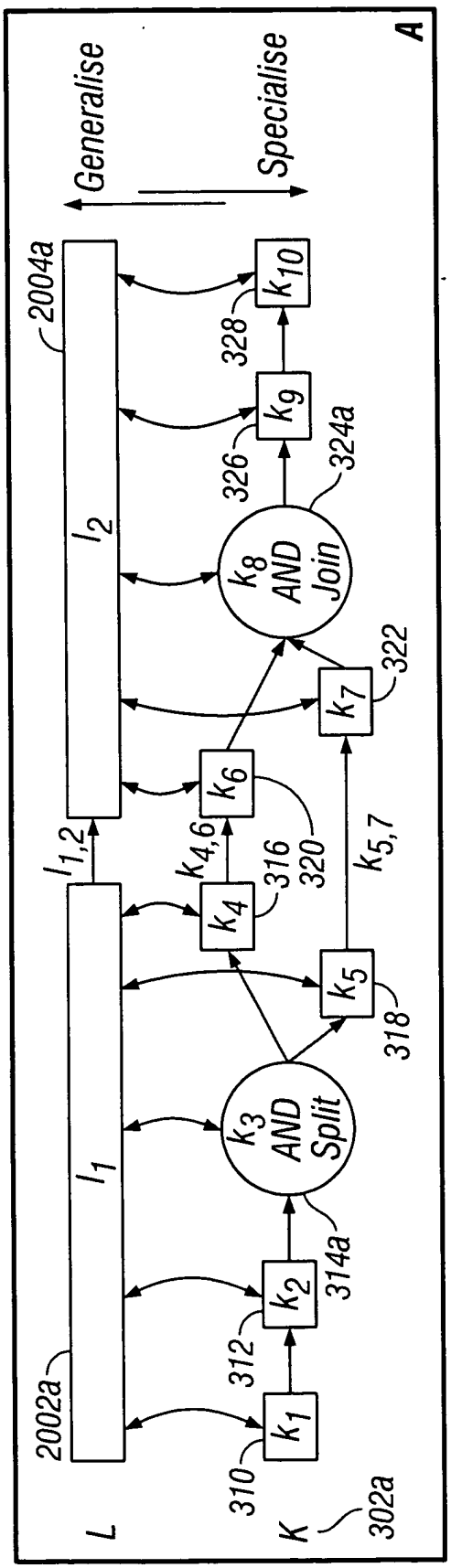

FIG. 20A

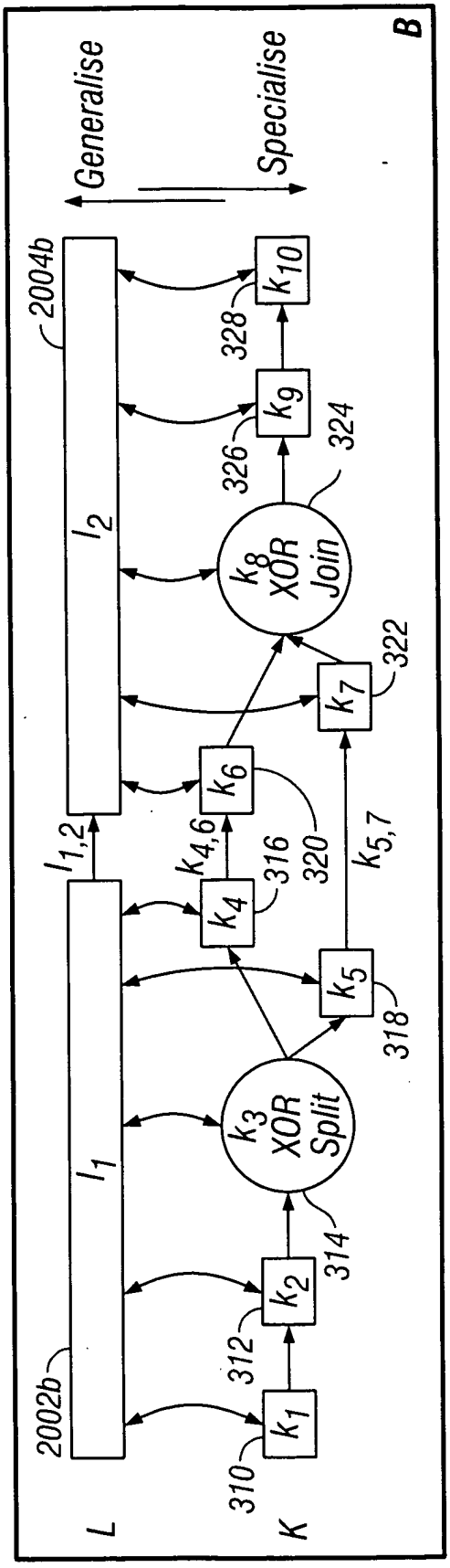

FIG. 20B

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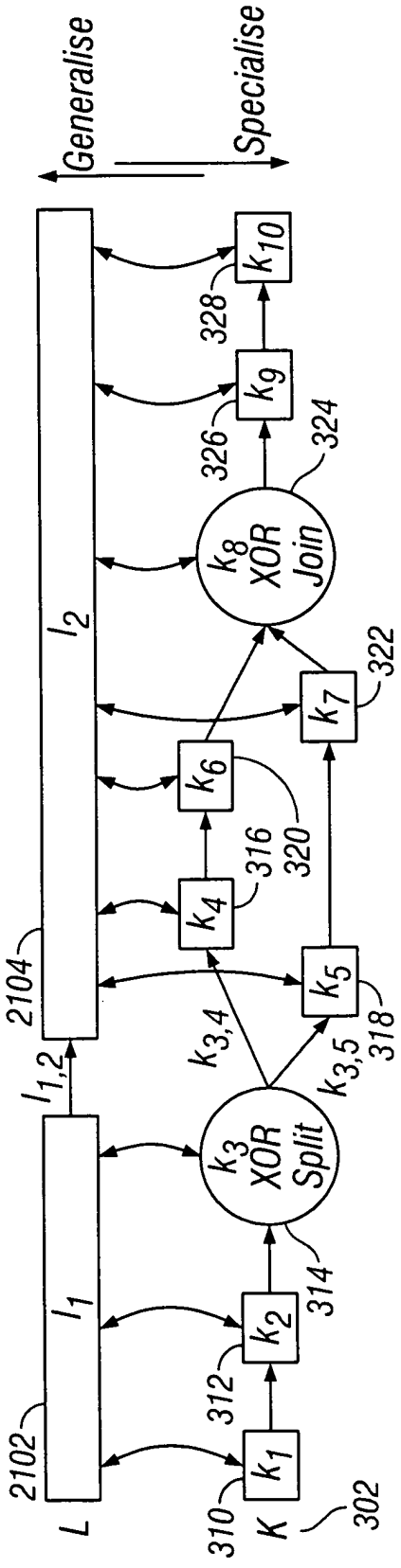
Generalise
Specialise
L
K
l_1
l_2
$l_{1,2}$
k_1
k_2
k_3 XOR Split
k_4
k_5
k_6
k_7
k_8 XOR Join
k_9
k_{10}
$k_{3,4}$
$k_{3,5}$
2102
2104
302
310
312
314
316
318
320
322
324
326
328

FIG. 21

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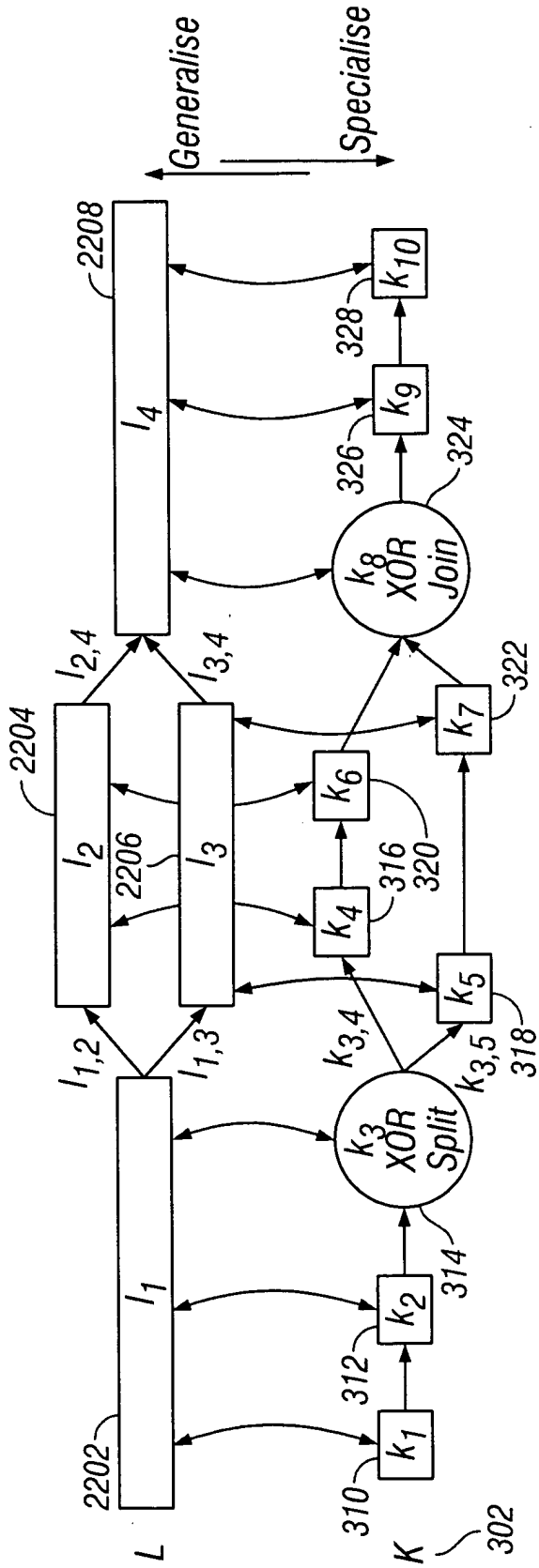

FIG. 22

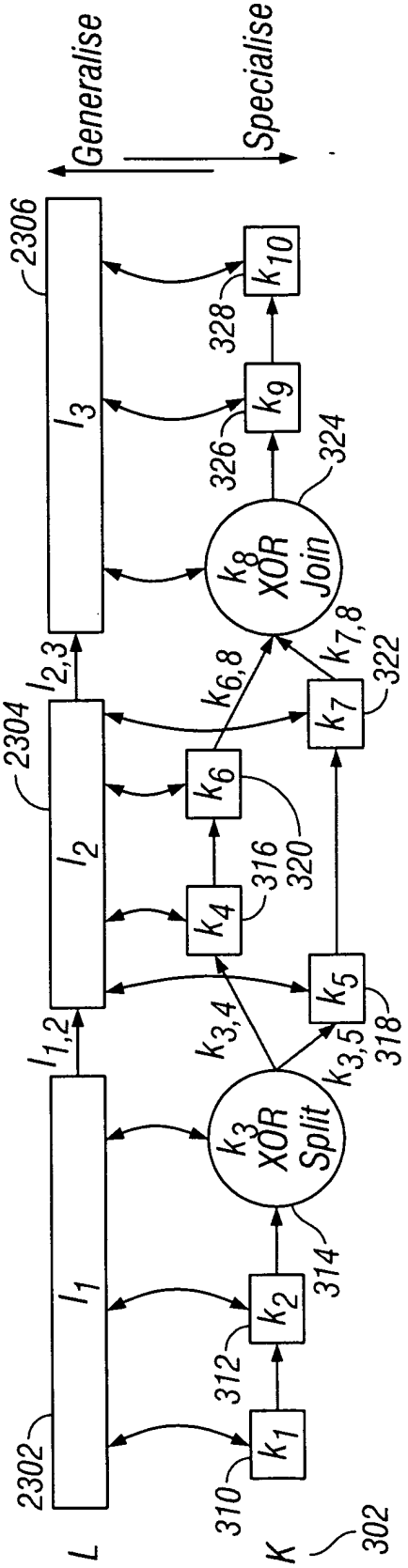

FIG. 23

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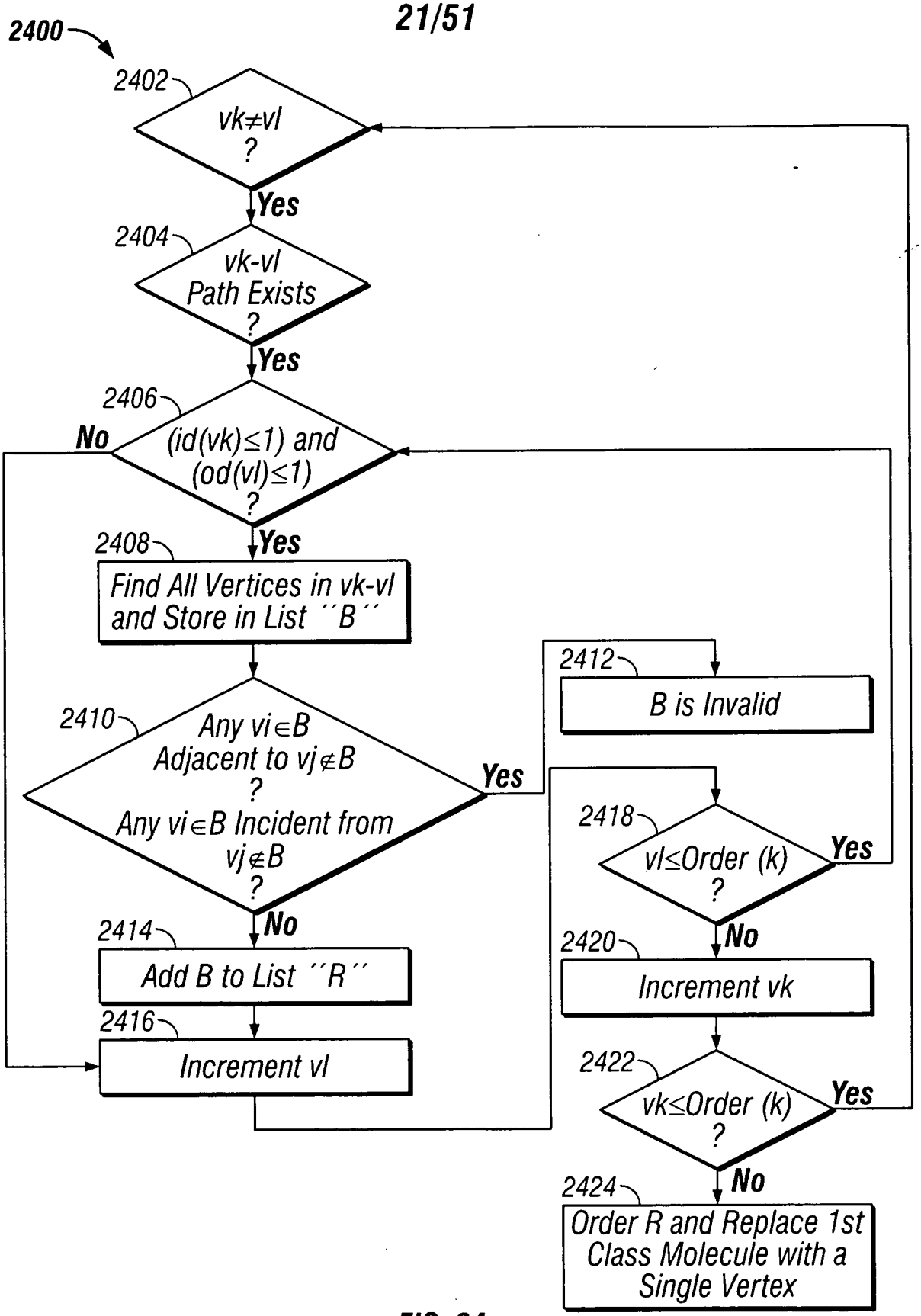
2400
2402
vk≠vl ?
Yes
2404
vk-vl Path Exists ?
Yes
2406
No
(id(vk)≤1) and (od(vl)≤1) ?
Yes
2408
Find All Vertices in vk-vl and Store in List ''B''
2410
Any vi∈B Adjacent to vj∉B ?
Any vi∈B Incident from vj∉B ?
Yes
2412
B is Invalid
No
2414
Add B to List ''R''
2416
Increment vl
2418
vl≤Order (k) ?
Yes
No
2420
Increment vk
2422
vk≤Order (k) ?
Yes
No
2424
Order R and Replace 1st Class Molecule with a Single Vertex

FIG. 24

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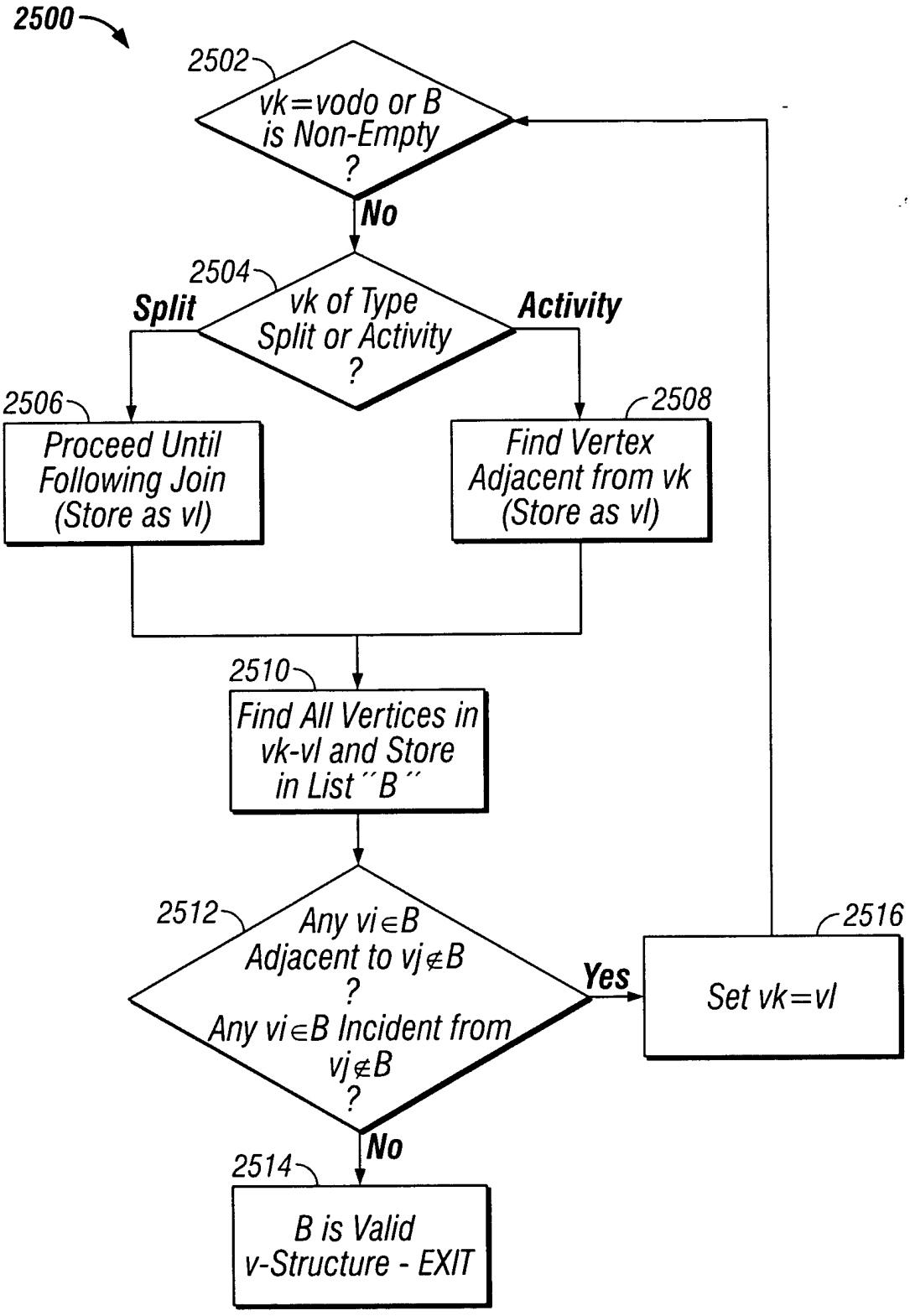
2500
2502
vk=vodo or B is Non-Empty ?
No
2504
vk of Type Split or Activity ?
Split
Activity
2506
Proceed Until Following Join (Store as vl)
2508
Find Vertex Adjacent from vk (Store as vl)
2510
Find All Vertices in vk-vl and Store in List "B"
2512
Any vi∈B Adjacent to vj∉B ?
Any vi∈B Incident from vj∉B ?
Yes
2516
Set vk=vl
No
2514
B is Valid v-Structure - EXIT

FIG. 25

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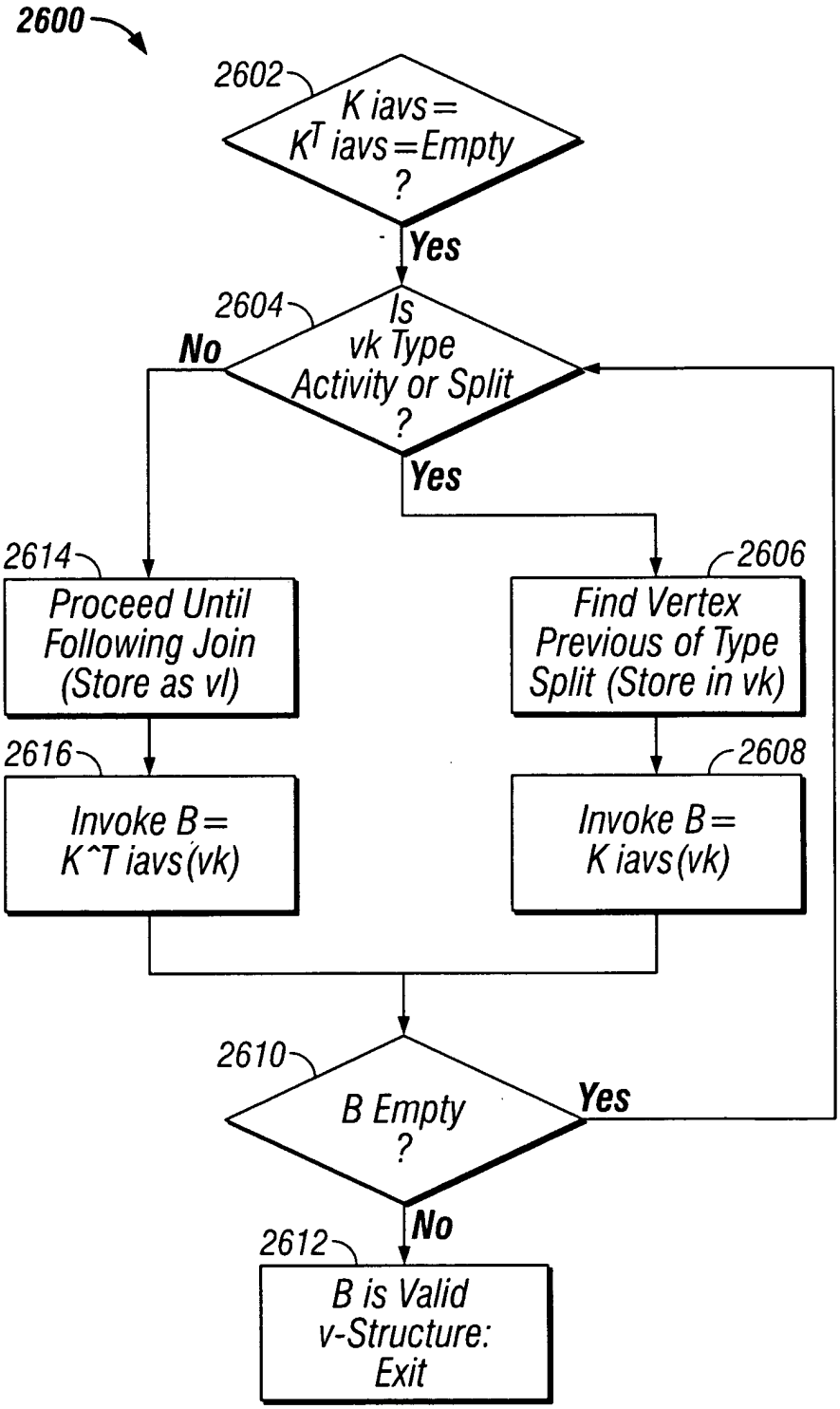
2600
2602
K iavs = K^T iavs = Empty ?
Yes
2604
Is vk Type Activity or Split ?
No
Yes
2614
Proceed Until Following Join (Store as vl)
2606
Find Vertex Previous of Type Split (Store in vk)
2616
Invoke B = K^T iavs(vk)
2608
Invoke B = K iavs(vk)
2610
B Empty ?
Yes
No
2612
B is Valid v-Structure: Exit

FIG. 26

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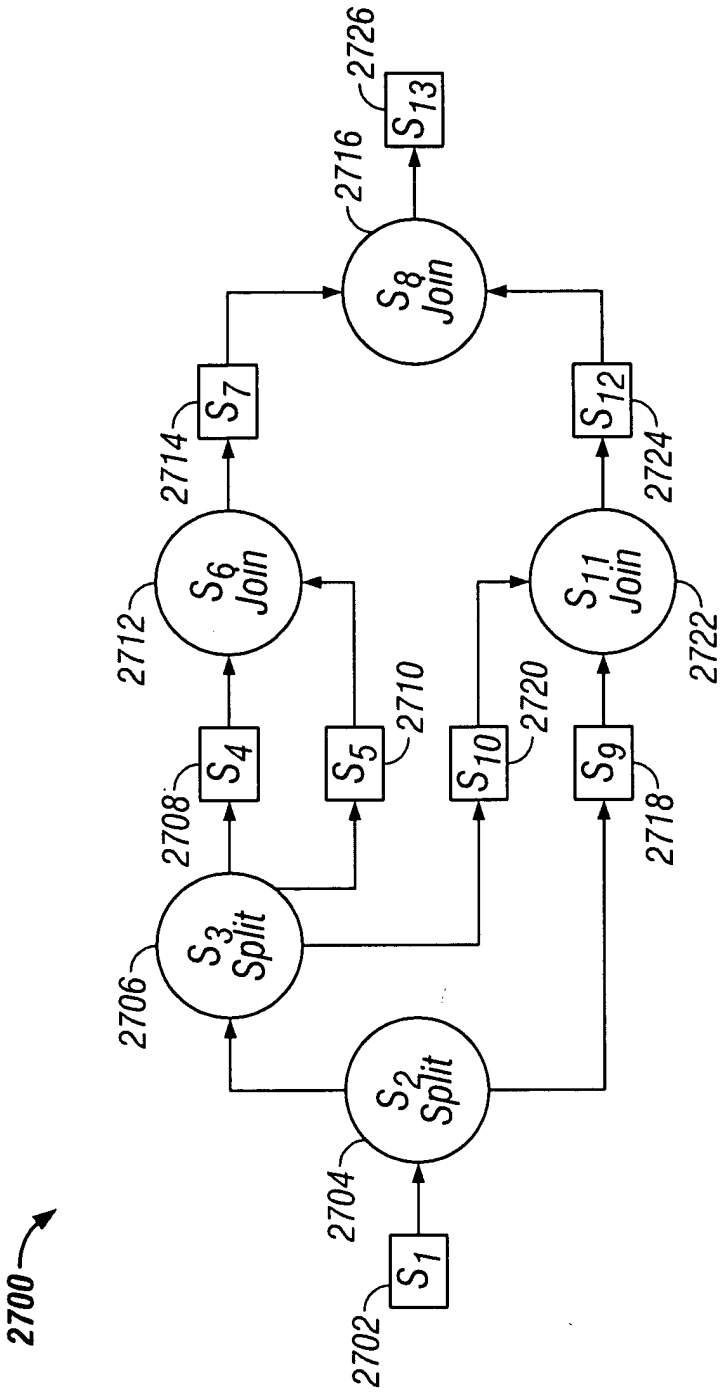
2700
2702
S1
2704
S2 Split
2706
S3 Split
2708
S4
S5
2710
2712
S6 Join
2714
S7
2716
S8 Join
2718
S9
S10
2720
2722
S11 Join
2724
S12
2726
S13

FIG. 27A

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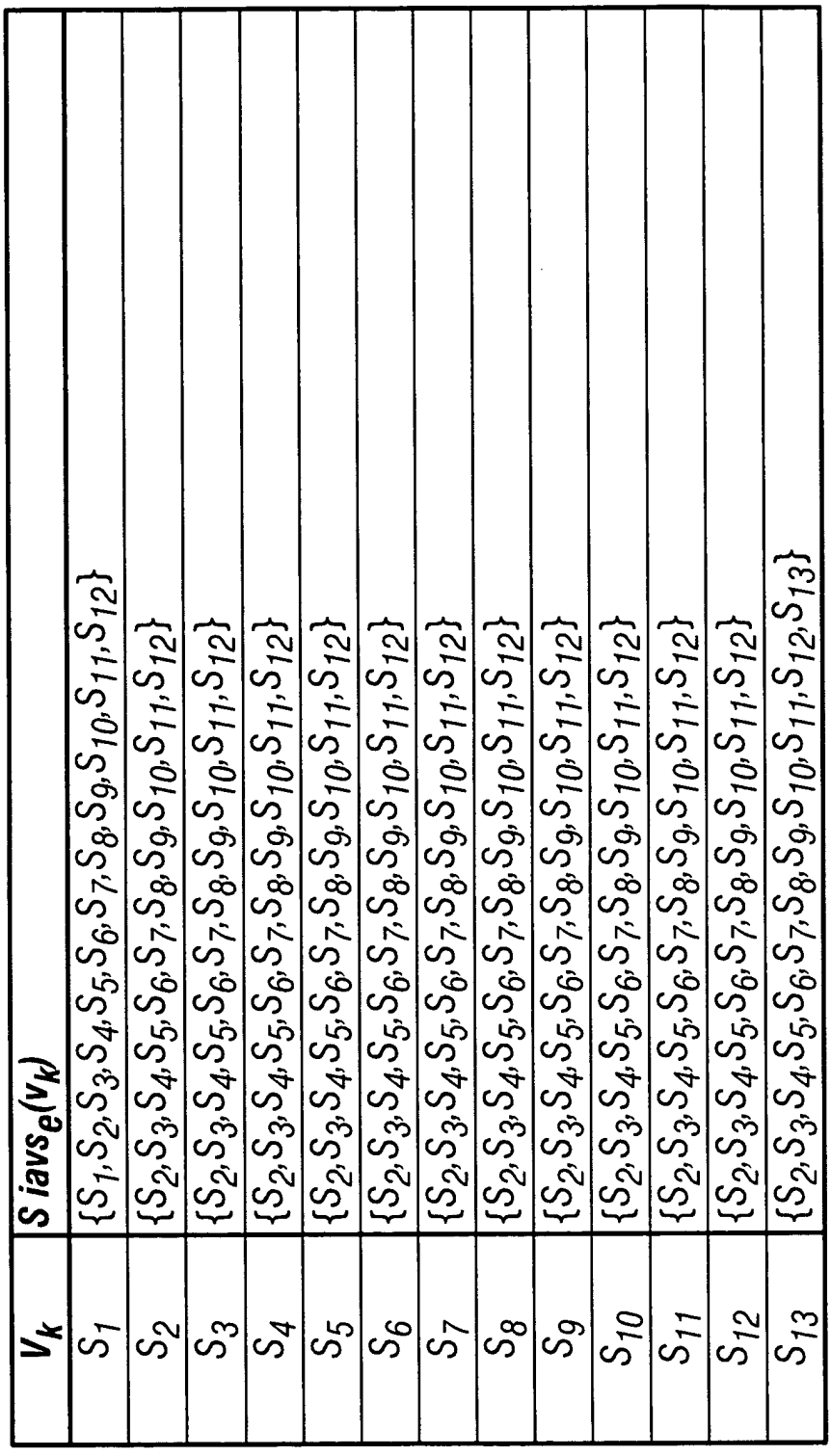

V_k	$S\ iavs_e(v_k)$
S_1	$\{S_1,S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_2	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_3	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_4	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_5	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_6	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_7	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_8	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_9	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_{10}	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_{11}	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_{12}	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12}\}$
S_{13}	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{11},S_{12},S_{13}\}$

FIG. 27B

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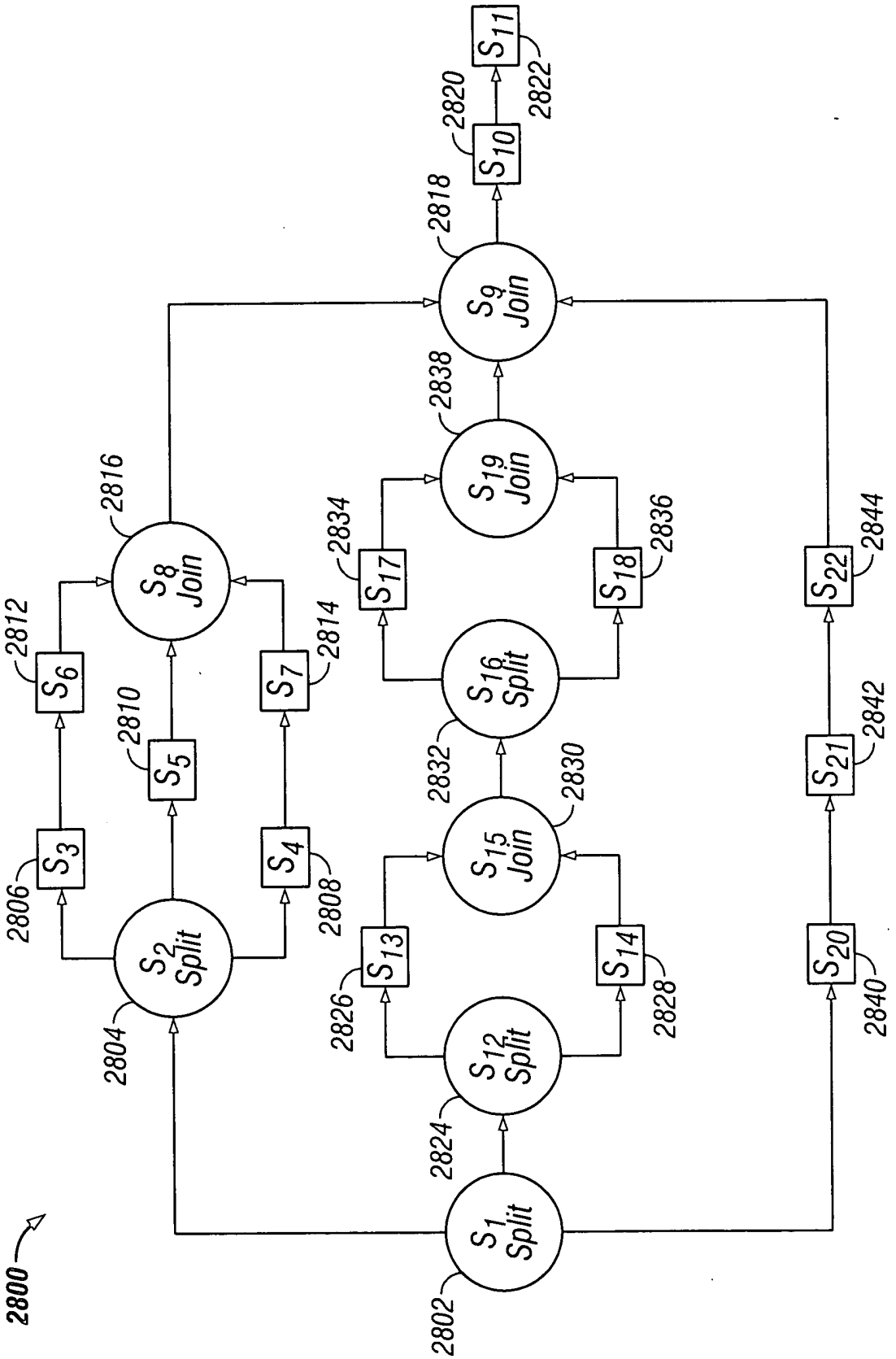
2800
2802
S1 Split
2824
S12 Split
2826
S13
2828
S14
2804
S2 Split
2806
S3
2808
S4
2810
S5
2812
S6
2814
S7
2816
S8 Join
2818
S9 Join
2820
S10
2822
S11
2830
S15 Join
2832
S16 Split
2834
S17
2836
S18
2838
S19 Join
2840
S20
2842
S21
2844
S22

FIG. 28A

V_k	$S\ iavs_e(V_k)$
S_1	$\{S_1,S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{12},S_{13},S_{14},S_{15},S_{16},S_{17},S_{18},S_{19},S_{20},S_{21},S_{22}\}$
S_2	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8\}$
S_3	$\{S_3,S_6\}$
S_4	$\{S_4,S_7\}$
S_5	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8\}$
S_6	$\{S_3,S_6\}$
S_7	$\{S_4,S_7\}$
S_8	$\{S_2,S_3,S_4,S_5,S_6,S_7,S_8\}$
S_9	$\{S_1,S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{12},S_{13},S_{14},S_{15},S_{16},S_{17},S_{18},S_{19},S_{20},S_{21},S_{22}\}$
S_{10}	$\{S_1,S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10},S_{12},S_{13},S_{14},S_{15},S_{16},S_{17},S_{18},S_{19},S_{20},S_{21},S_{22}\}$, $\{S_{10},S_{11}\}$
S_{11}	$\{S_{10},S_{11}\}$
S_{12}	$\{S_{12},S_{13},S_{14},S_{15}\}$
S_{13}	$\{S_{12},S_{13},S_{14},S_{15}\}$
S_{14}	$\{S_{12},S_{13},S_{14},S_{15}\}$
S_{15}	$\{S_{12},S_{13},S_{14},S_{15}\}$
S_{16}	$\{S_{16},S_{17},S_{18},S_{19}\}$
S_{17}	$\{S_{16},S_{17},S_{18},S_{19}\}$
S_{18}	$\{S_{16},S_{17},S_{18},S_{19}\}$
S_{19}	$\{S_{16},S_{17},S_{18},S_{19}\}$
S_{20}	$\{S_{20},S_{21}\}$
S_{21}	$\{S_{20},S_{21}\},\{S_{21},S_{22}\}$
S_{22}	$\{S_{21},S_{22}\}$

FIG. 28B

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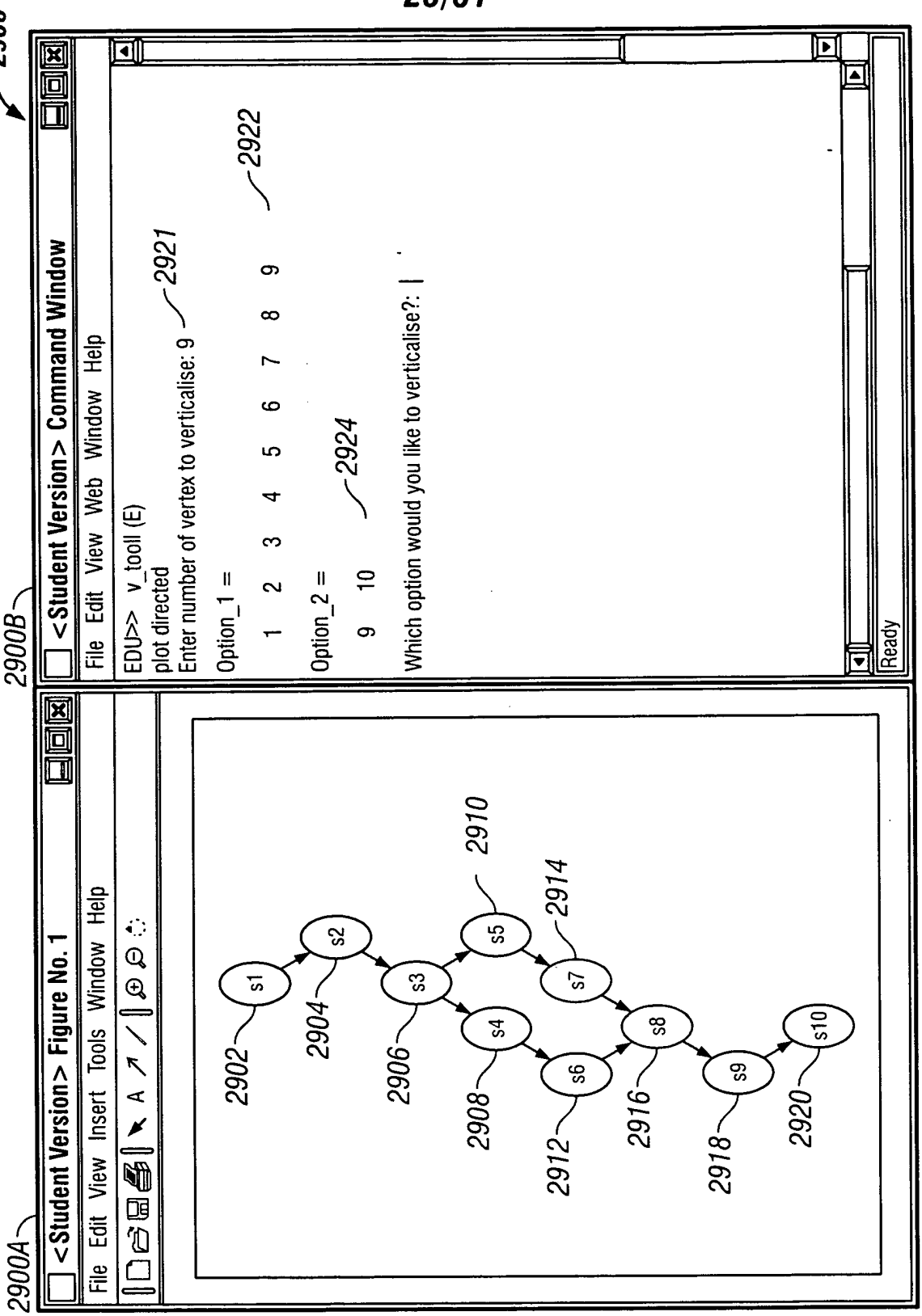
2900
2900A
2900B
<Student Version> Figure No. 1
File Edit View Insert Tools Window Help
<Student Version> Command Window
File Edit View Web Window Help
EDU>> v_tooll (E)
plot directed
Enter number of vertex to verticalise: 9
2921
Option_1 =
1 2 3 4 5 6 7 8 9
2922
Option_2 =
9 10
2924
Which option would you like to verticalise?:
Ready
s1
s2
s3
s4
s5
s6
s7
s8
s9
s10
2902
2904
2906
2908
2910
2912
2914
2916
2918
2920

FIG. 29

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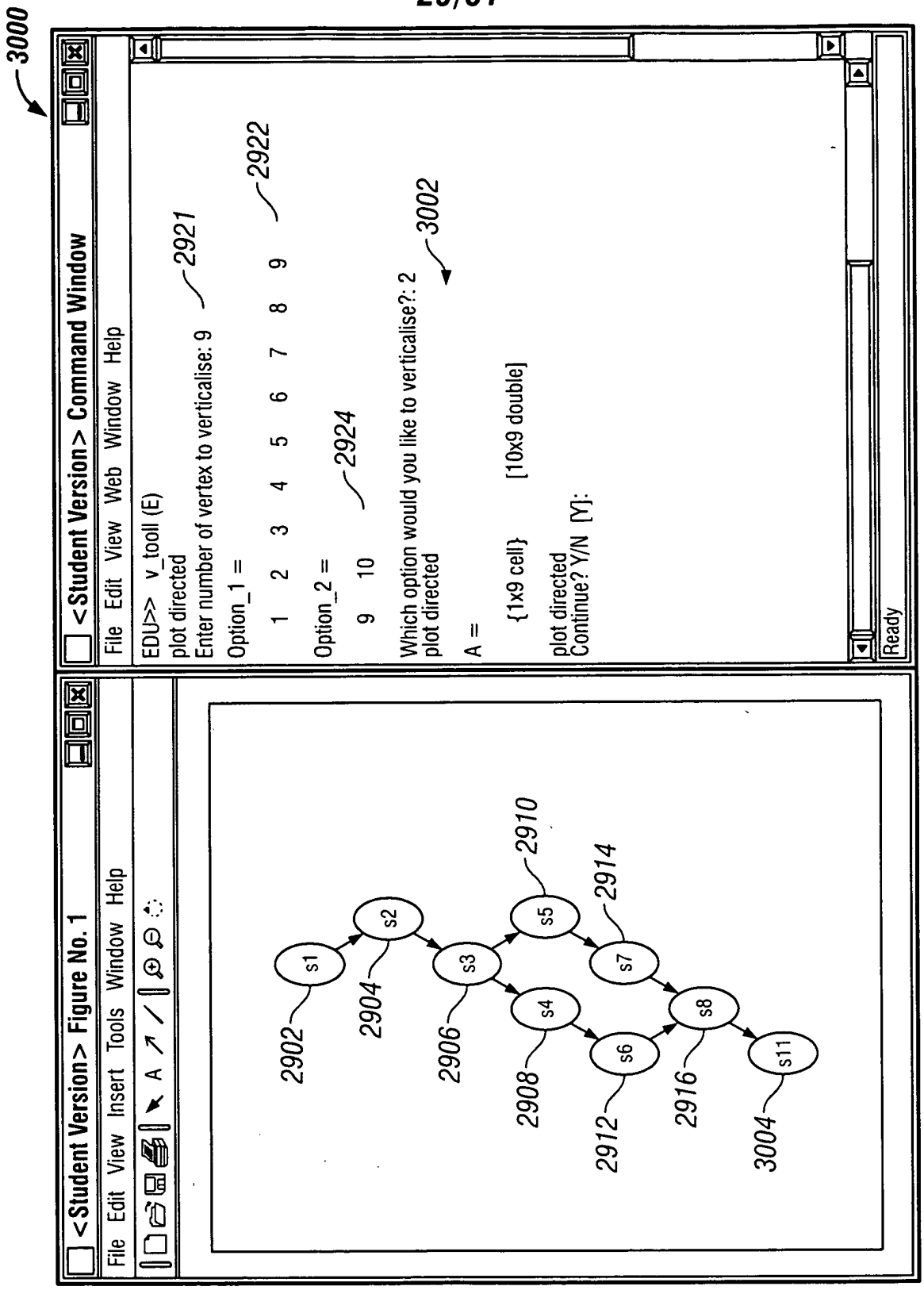
3000
<Student Version> Figure No. 1
File Edit View Insert Tools Window Help
<Student Version> Command Window
File Edit View Web Window Help
EDU>> v_tooll (E)
plot directed
Enter number of vertex to verticalise: 9
2921
Option_1 =
1 2 3 4 5 6 7 8 9
2922
Option_2 =
9 10
2924
Which option would you like to verticalise?: 2
3002
plot directed
A =
{1x9 cell} [10x9 double]
plot directed
Continue? Y/N [Y]:
Ready
s1
s2
s3
s4
s5
s6
s7
s8
s11
2902
2904
2906
2908
2910
2912
2914
2916
3004

FIG. 30

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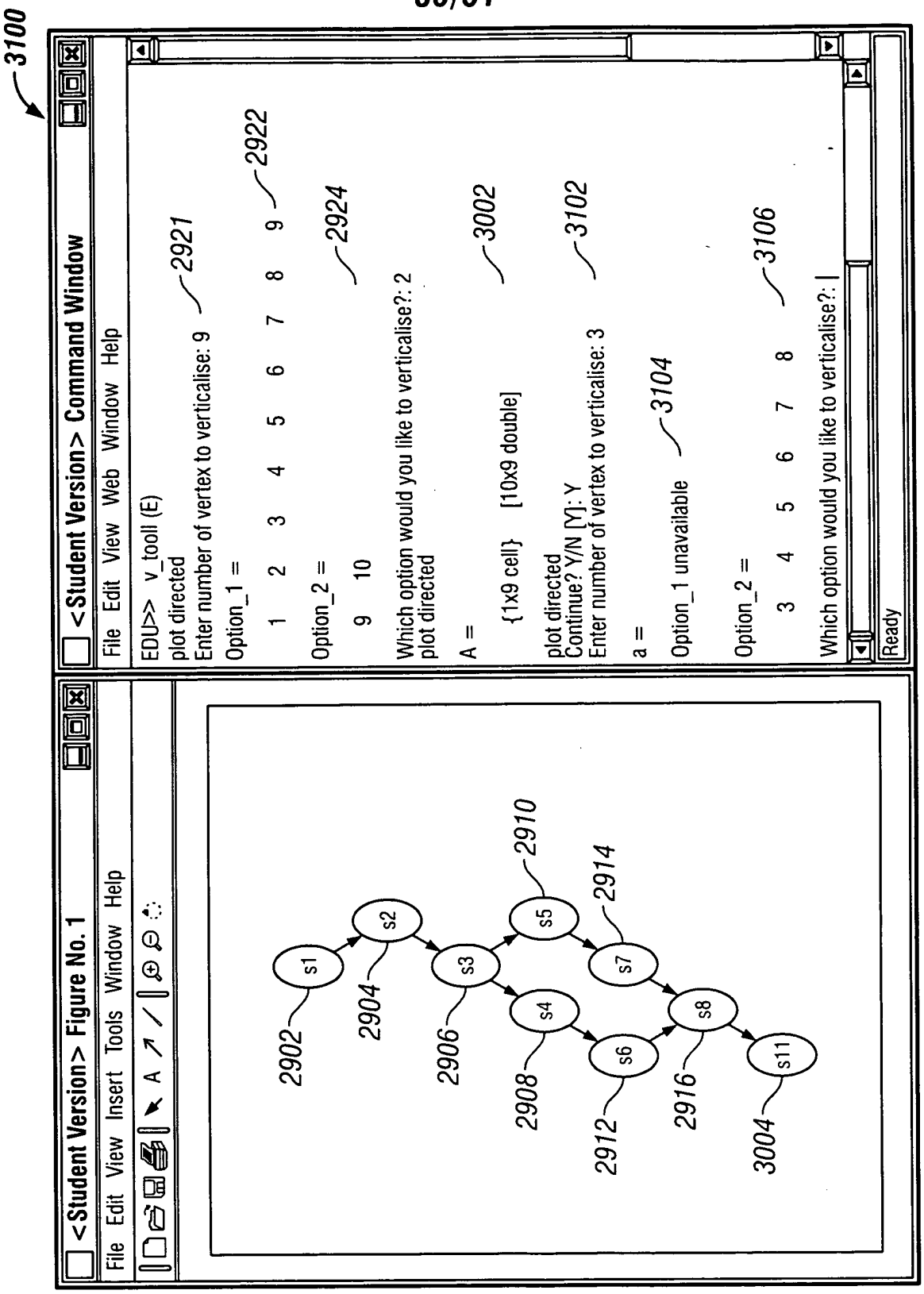
3100
<Student Version> Figure No. 1
File Edit View Insert Tools Window Help
A
s1
s2
s3
s4
s5
s6
s7
s8
s11
2902
2904
2906
2908
2910
2912
2914
2916
3004
<Student Version> Command Window
File Edit View Web Window Help
EDU>> v_tooll (E)
plot directed
Enter number of vertex to verticalise: 9
2921
Option_1 =
1 2 3 4 5 6 7 8 9
2922
Option_2 =
9 10
2924
Which option would you like to verticalise?: 2
plot directed
A =
3002
{1x9 cell} [10x9 double]
plot directed
Continue? Y/N [Y]: Y
Enter number of vertex to verticalise: 3
3102
a =
Option_1 unavailable
3104
Option_2 =
3 4 5 6 7 8
3106
Which option would you like to verticalise?:
Ready

FIG. 31

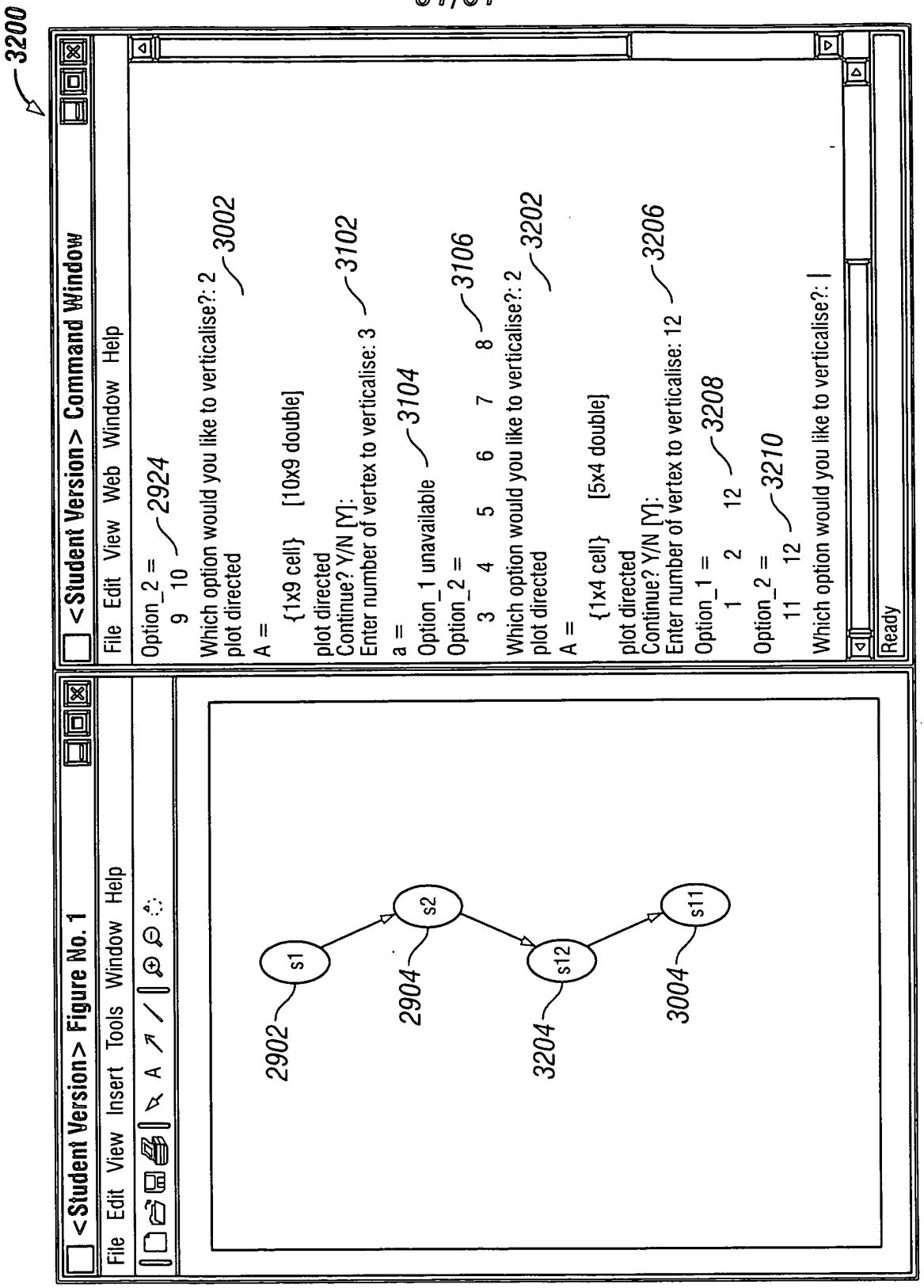
3200
<Student Version> Figure No. 1
File Edit View Insert Tools Window Help
s1
s2
s12
s11
2902
2904
3204
3004
<Student Version> Command Window
File Edit View Web Window Help
Option_2 =
9 10
2924
Which option would you like to verticalise?: 2
3002
plot directed
A =
{1x9 cell} [10x9 double]
plot directed
Continue? Y/N [Y]:
Enter number of vertex to verticalise: 3
3102
a =
Option_1 unavailable
3104
Option_2 =
3 4 5 6 7 8
3106
Which option would you like to verticalise?: 2
3202
plot directed
A =
{1x4 cell} [5x4 double]
plot directed
Continue? Y/N [Y]:
Enter number of vertex to verticalise: 12
3206
Option_1 =
1 2 12
3208
Option_2 =
11 12
3210
Which option would you like to verticalise?:
Ready

FIG. 32

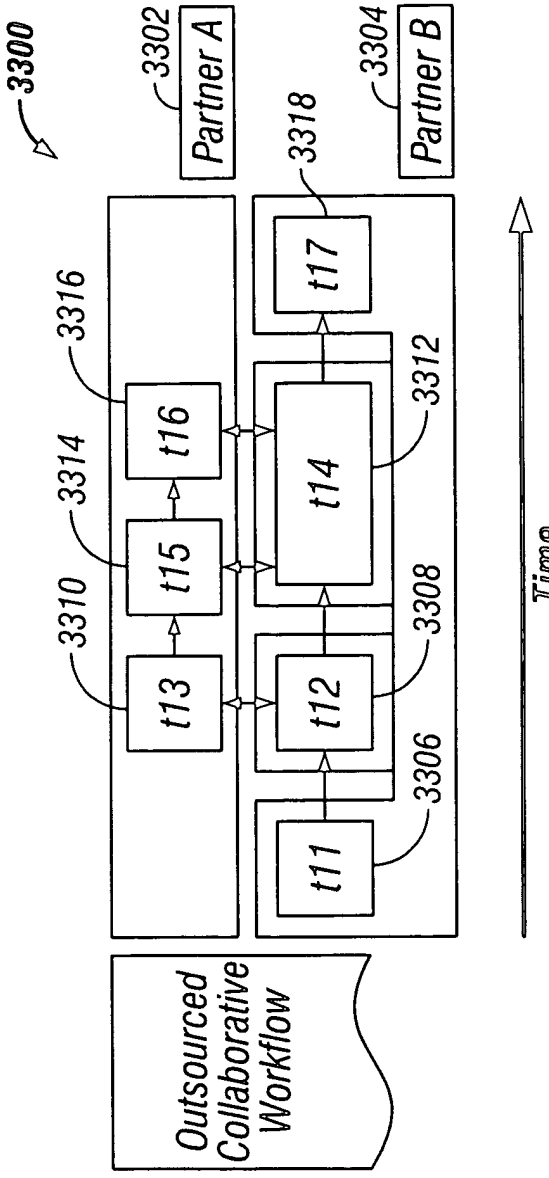
3300
3302
Partner A
3304
Partner B
3316
3314
3310
3318
3312
3308
3306
t13
t15
t16
t11
t12
t14
t17
Outsourced Collaborative Workflow
Time

FIG. 33

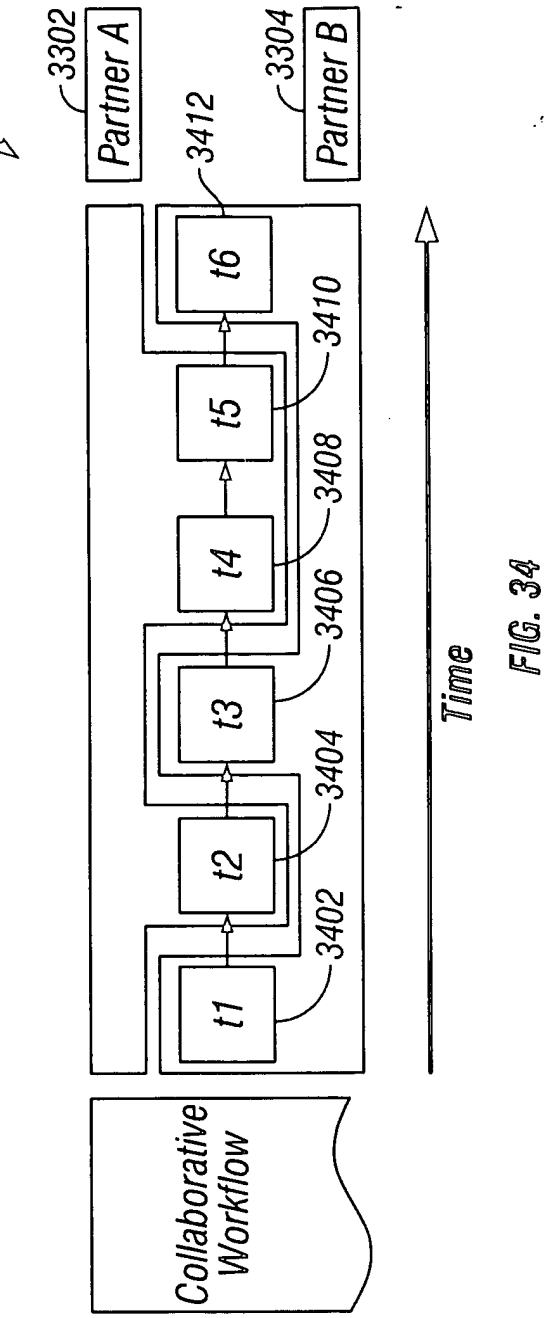
3400
3302
Partner A
3304
Partner B
3412
3410
3408
3406
3404
3402
t1
t2
t3
t4
t5
t6
Collaborative Workflow
Time

FIG. 34

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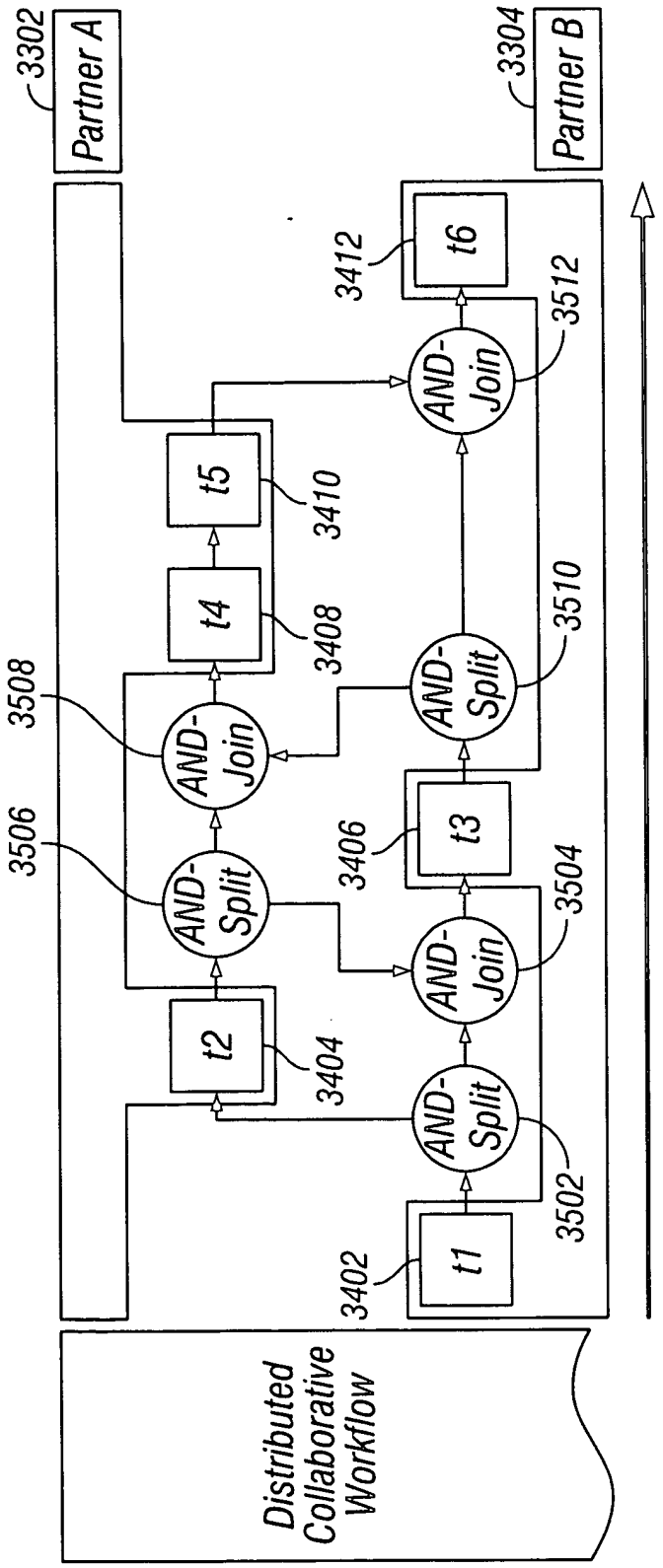
Distributed Collaborative Workflow
Partner A
3302
Partner B
3304
t1
3402
t2
3404
t3
3406
t4
3408
t5
3410
t6
3412
AND-Split
3502
AND-Join
3504
AND-Split
3506
AND-Join
3508
AND-Split
3510
AND-Join
3512
Time

FIG. 35

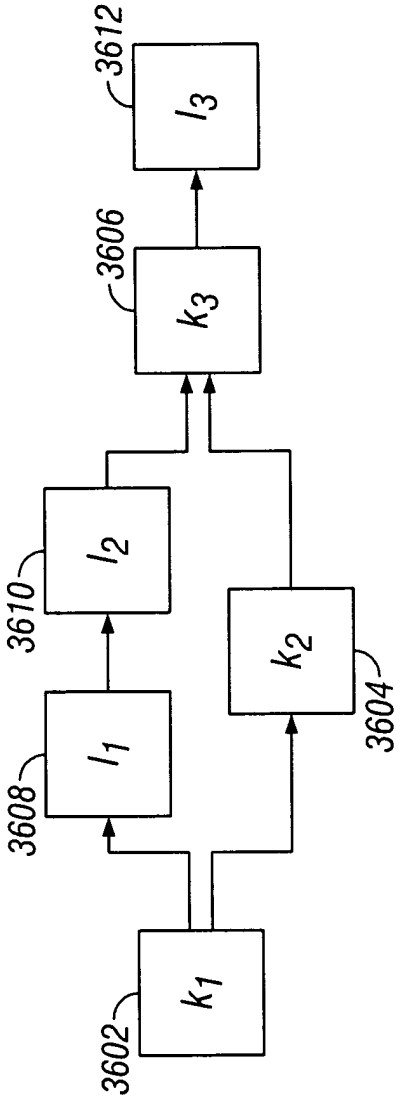
3612
l_3
3606
k_3
3610
l_2
3608
l_1
k_2
3604
k_1
3602

FIG. 36

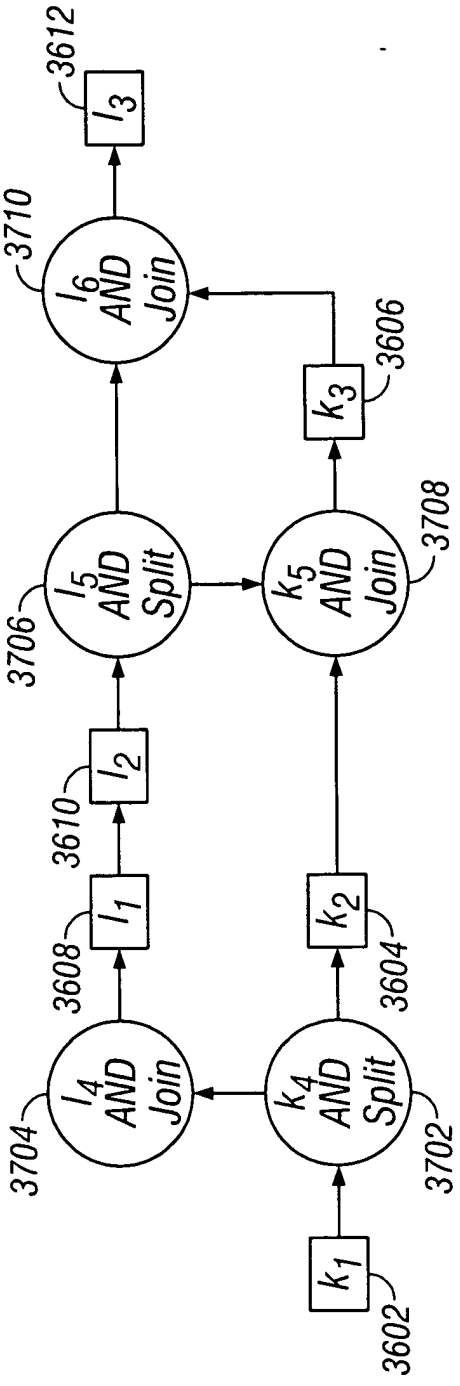
3612
l_3
3710
l_6 AND Join
3606
k_3
3706
l_5 AND Split
k_5 AND Join
3708
3610
l_2
3608
l_1
k_2
3604
3704
l_4 AND Join
k_4 AND Split
3702
k_1
3602

FIG. 37

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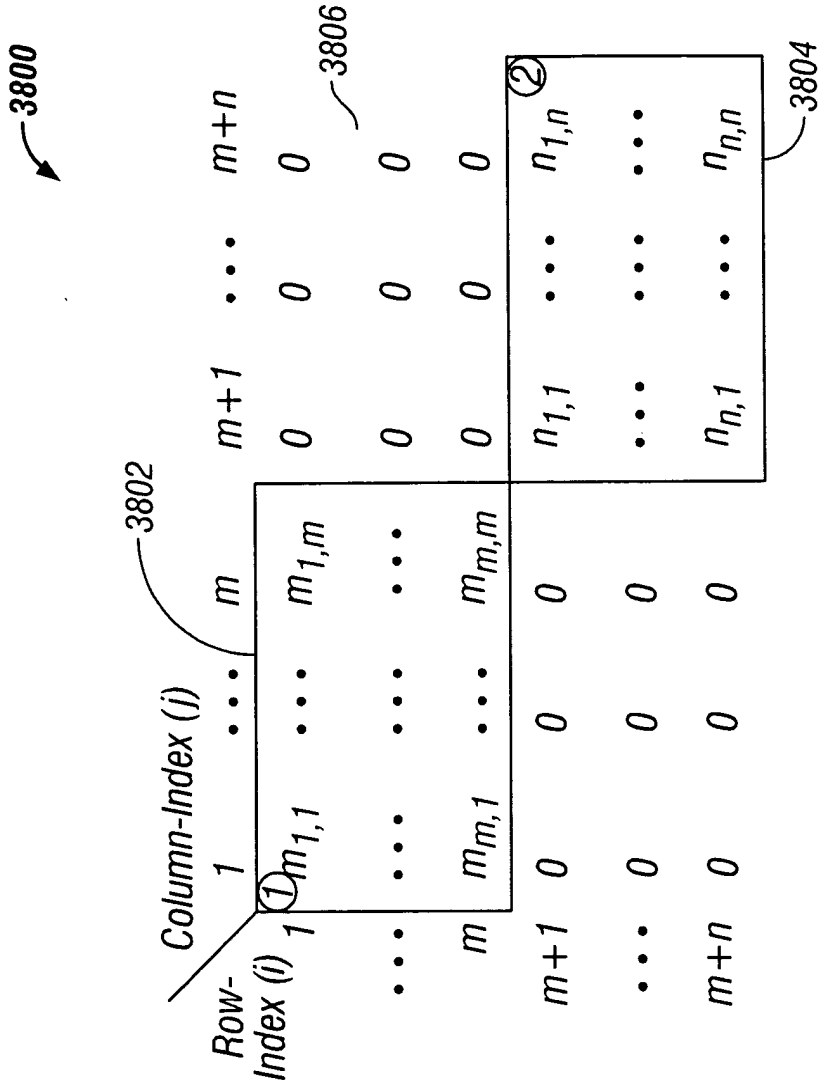
3800
3802
3804
3806
Column-Index (j)
Row-Index (i)
1
m
m+1
m+n
1
m
m+1
m+n
1
2

FIG. 38

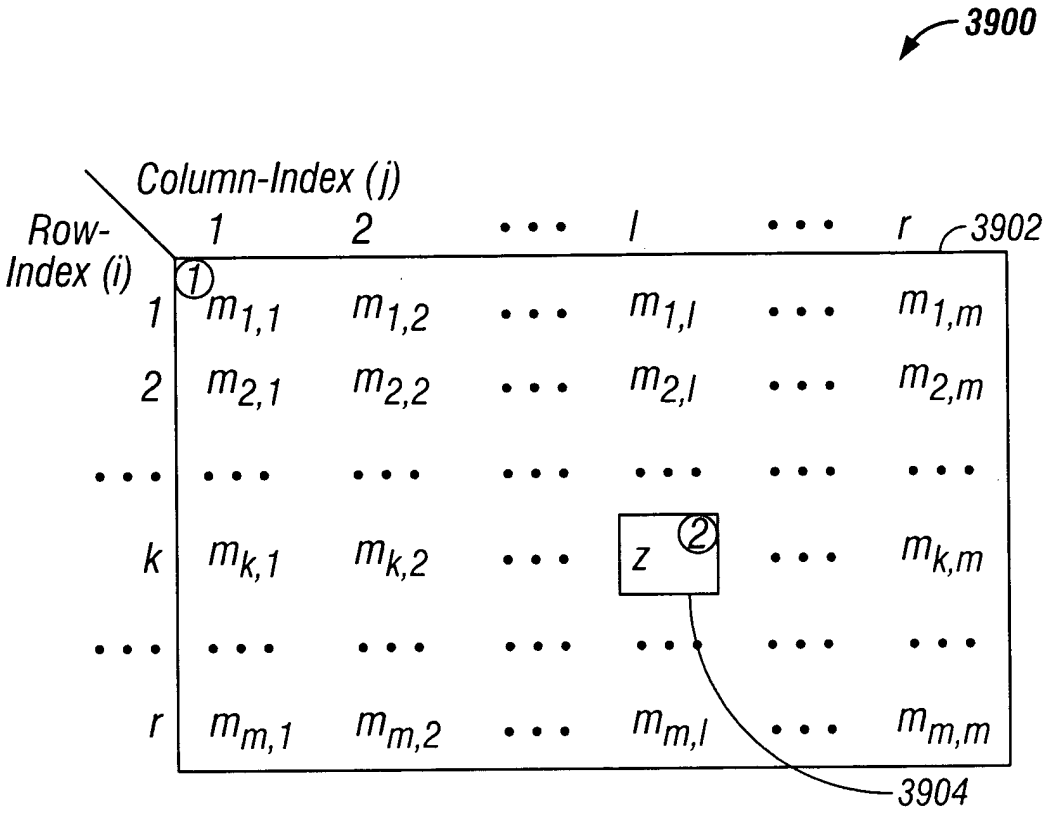
3900
Column-Index (j)
Row-Index (i)
1
2
l
r
3902
1
$m_{1,1}$ $m_{1,2}$ $m_{1,l}$ $m_{1,m}$
2
$m_{2,1}$ $m_{2,2}$ $m_{2,l}$ $m_{2,m}$
k
$m_{k,1}$ $m_{k,2}$ z $m_{k,m}$
r
$m_{m,1}$ $m_{m,2}$ $m_{m,l}$ $m_{m,m}$
3904

FIG. 39

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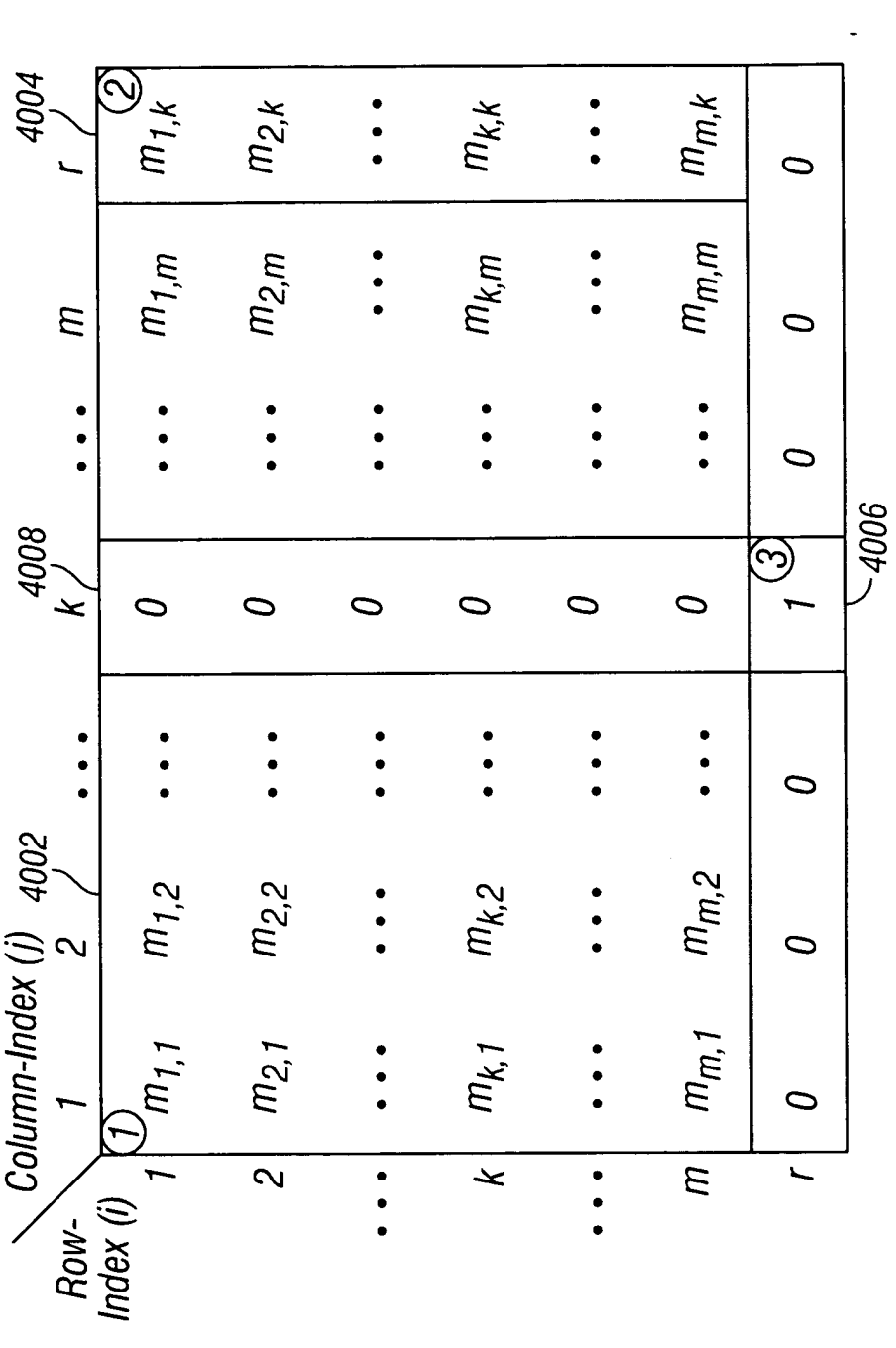
4000
Column-Index (j)
Row-Index (i)
4002
4004
4006
4008
1
2
k
m
r
1
2
k
m
r
$m_{1,1}$ $m_{1,2}$ ... $m_{1,k}$ ... $m_{1,m}$
$m_{2,1}$ $m_{2,2}$ ... $m_{2,k}$ ... $m_{2,m}$
$m_{k,1}$ $m_{k,2}$ ... $m_{k,k}$ ... $m_{k,m}$
$m_{m,1}$ $m_{m,2}$ ... $m_{m,k}$ ... $m_{m,m}$
0 0 ... 0 ... 0
0 0 ... 0 ... 0
0 0 ... 1 ... 0
0 0 ... 0 ... 0
①
②
③

FIG. 40

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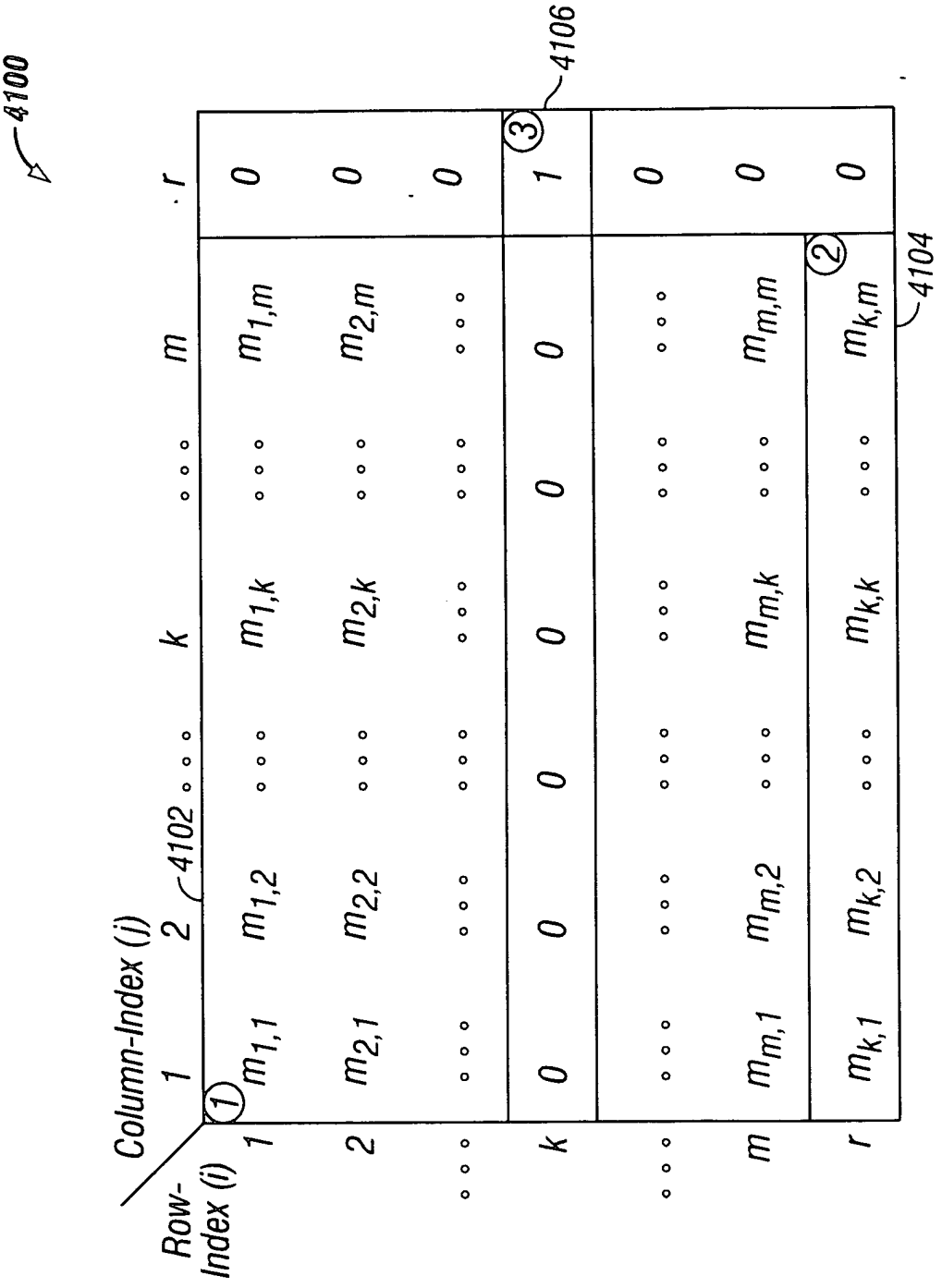
4100
4102
4104
4106
Column-Index (j)
Row-Index (i)
1
2
k
m
r
1
2
k
m
r
1
2
3
4
0
1
$m_{1,1}$
$m_{1,2}$
$m_{1,k}$
$m_{1,m}$
$m_{2,1}$
$m_{2,2}$
$m_{2,k}$
$m_{2,m}$
$m_{m,1}$
$m_{m,2}$
$m_{m,k}$
$m_{m,m}$
$m_{k,1}$
$m_{k,2}$
$m_{k,k}$
$m_{k,m}$

FIG. 41

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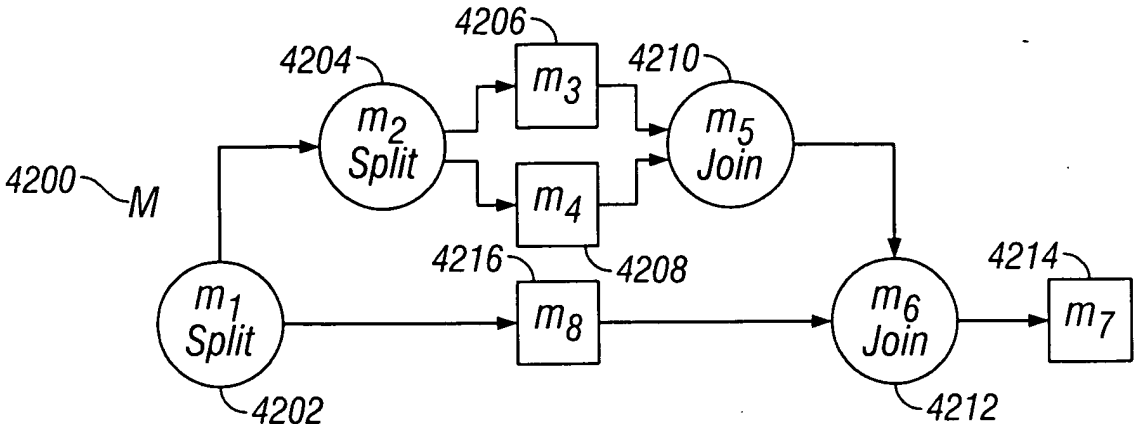

FIG. 42

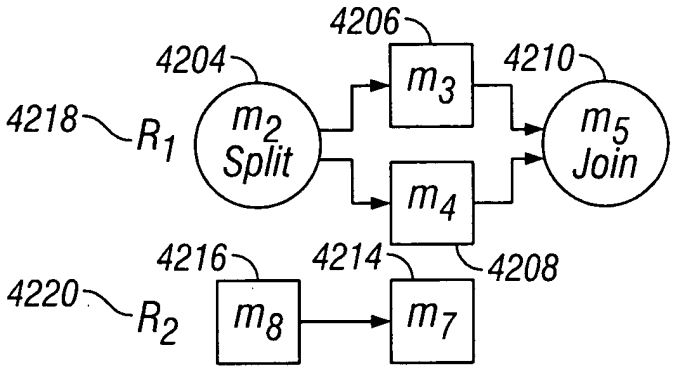

FIG. 42A

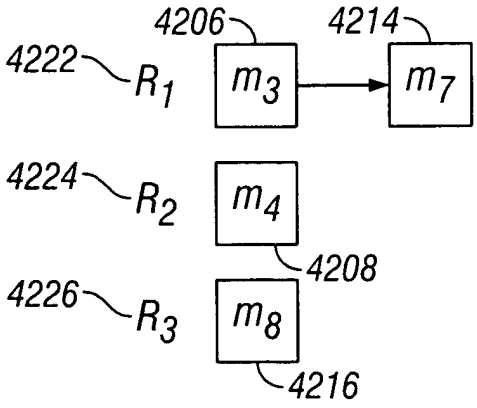

FIG. 42B

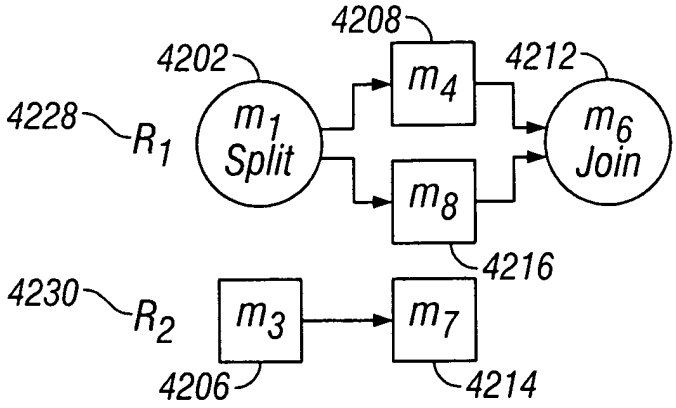

FIG. 42C

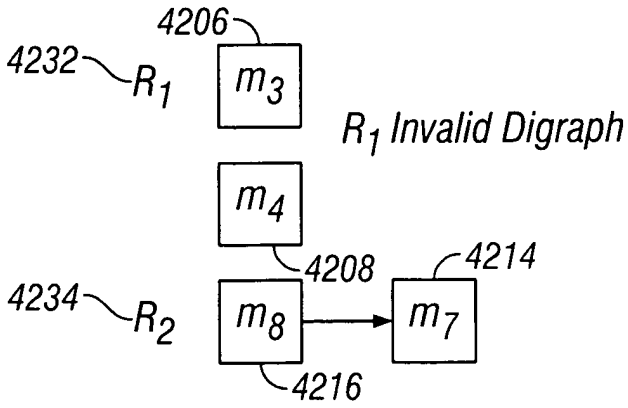

FIG. 42D

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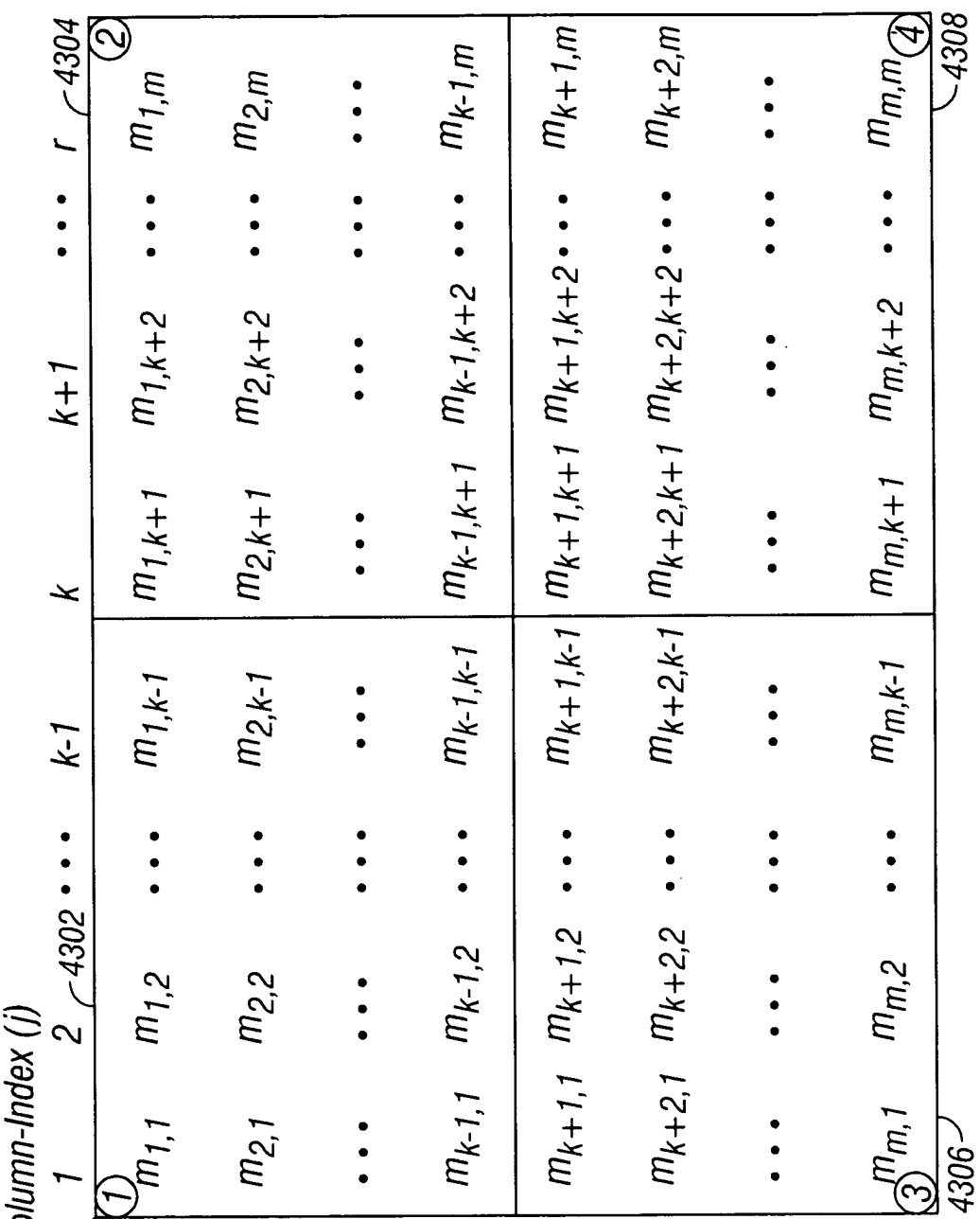
4300
Column-Index (j)
Row-Index (i)
1
2
4302
k-1
k
k+1
r
4304
1
2
3
4
4306
4308

FIG. 43

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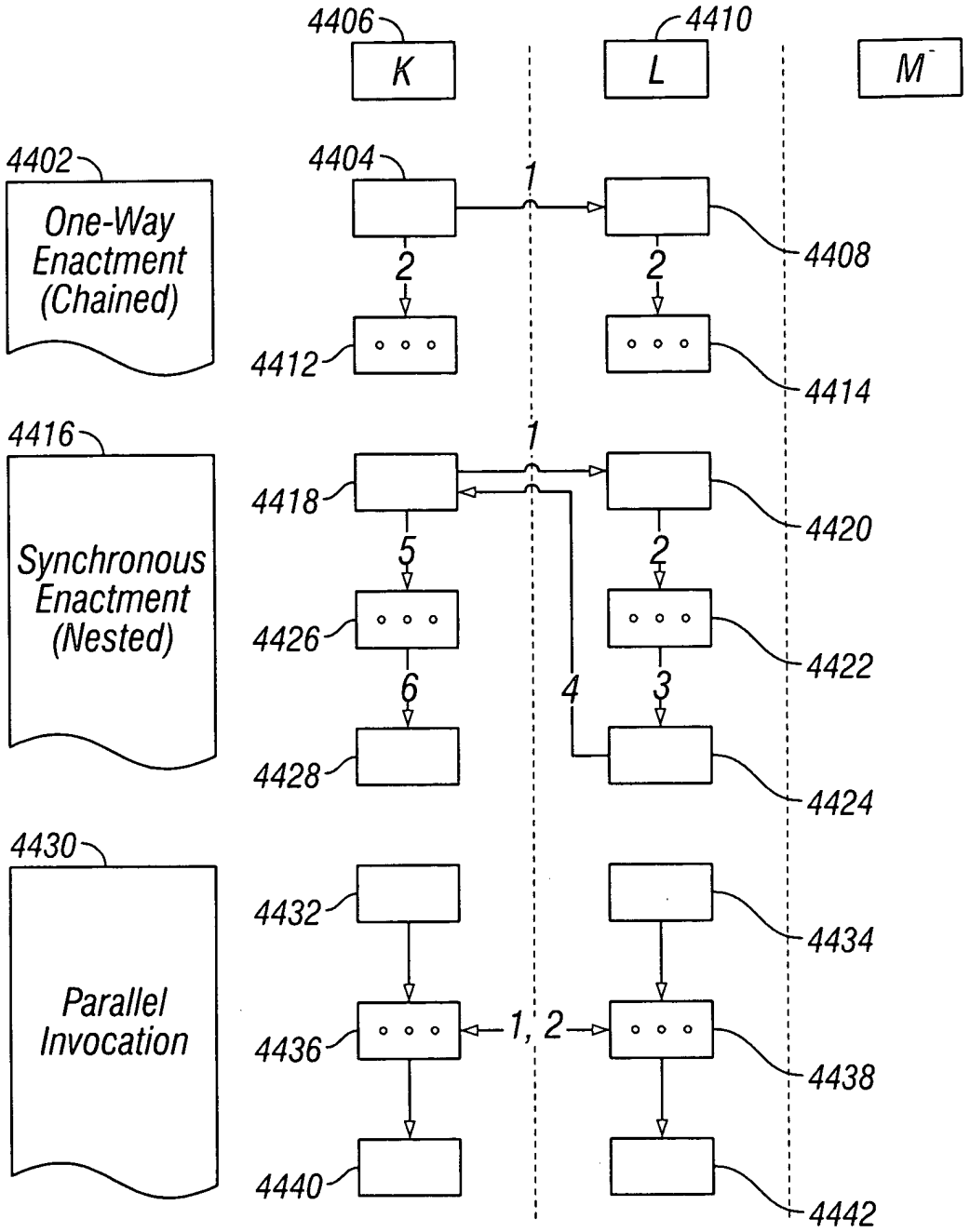
4406
K
4410
L
M
4402
One-Way Enactment (Chained)
4404
1
2
2
4408
4412
4414
4416
Synchronous Enactment (Nested)
1
4418
4420
5
2
4426
4422
6
4
3
4428
4424
4430
Parallel Invocation
4432
4434
4436
1, 2
4438
4440
4442

FIG. 44

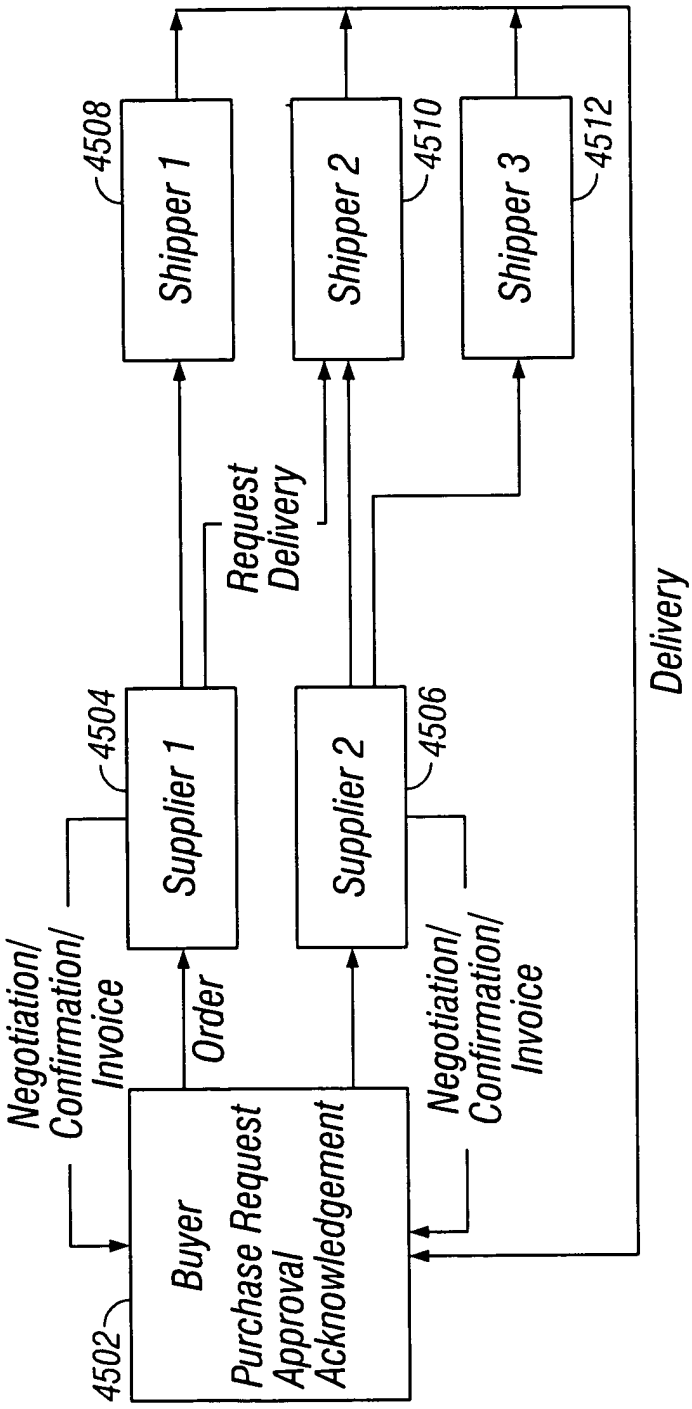
Shipper 1
4508
Shipper 2
4510
Shipper 3
4512
Request Delivery
Supplier 1
4504
Supplier 2
4506
Delivery
Negotiation/ Confirmation/ Invoice
Order
Negotiation/ Confirmation/ Invoice
Buyer
Purchase Request
Approval
Acknowledgement
4502

FIG. 45

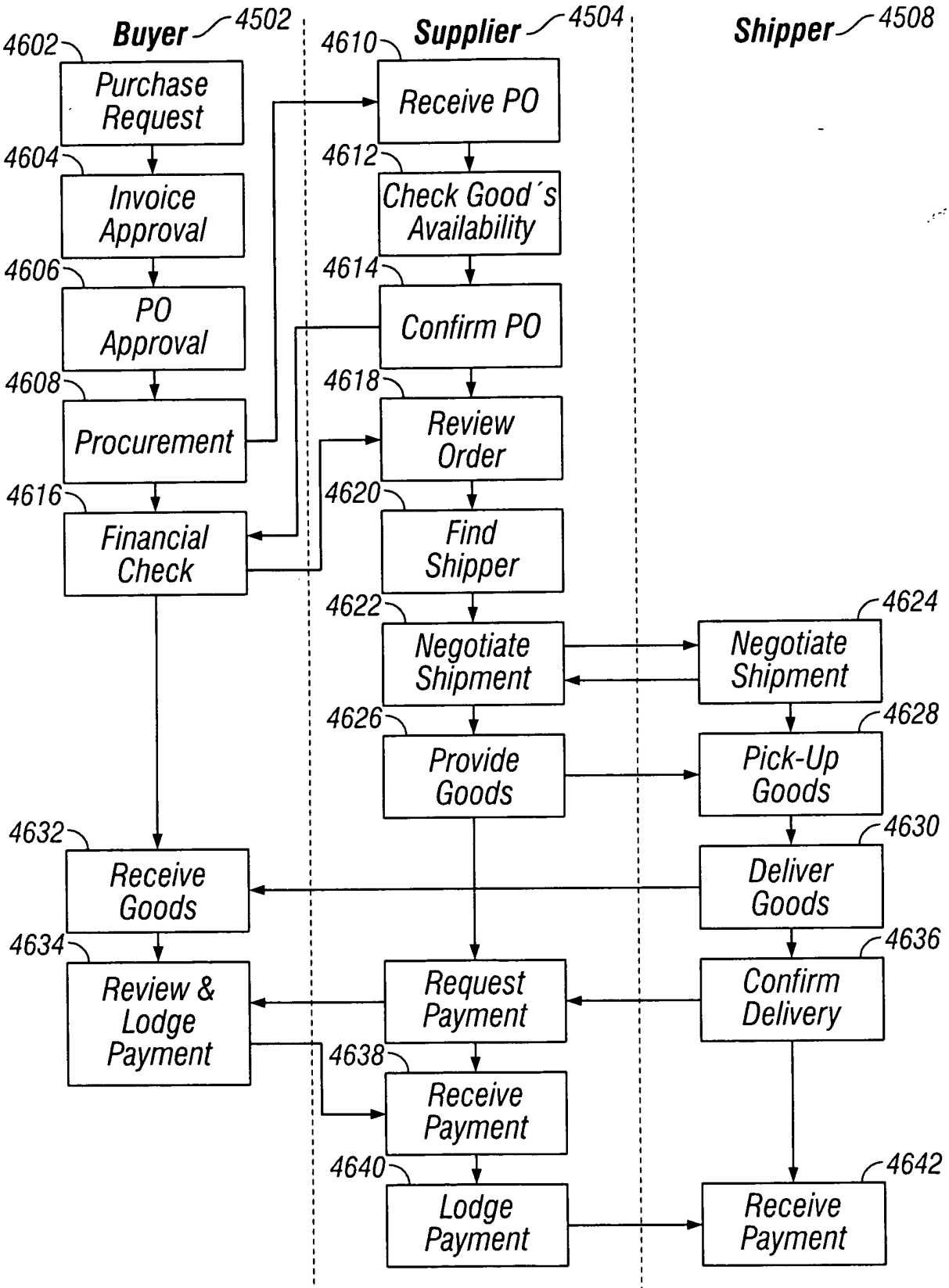
Buyer
4502
Supplier
4504
Shipper
4508
4602
Purchase Request
4604
Invoice Approval
4606
PO Approval
4608
Procurement
4616
Financial Check
4610
Receive PO
4612
Check Good´s Availability
4614
Confirm PO
4618
Review Order
4620
Find Shipper
4622
Negotiate Shipment
4624
Negotiate Shipment
4626
Provide Goods
4628
Pick-Up Goods
4630
Deliver Goods
4632
Receive Goods
4634
Review & Lodge Payment
4636
Confirm Delivery
Request Payment
4638
Receive Payment
4640
Lodge Payment
4642
Receive Payment

FIG. 46

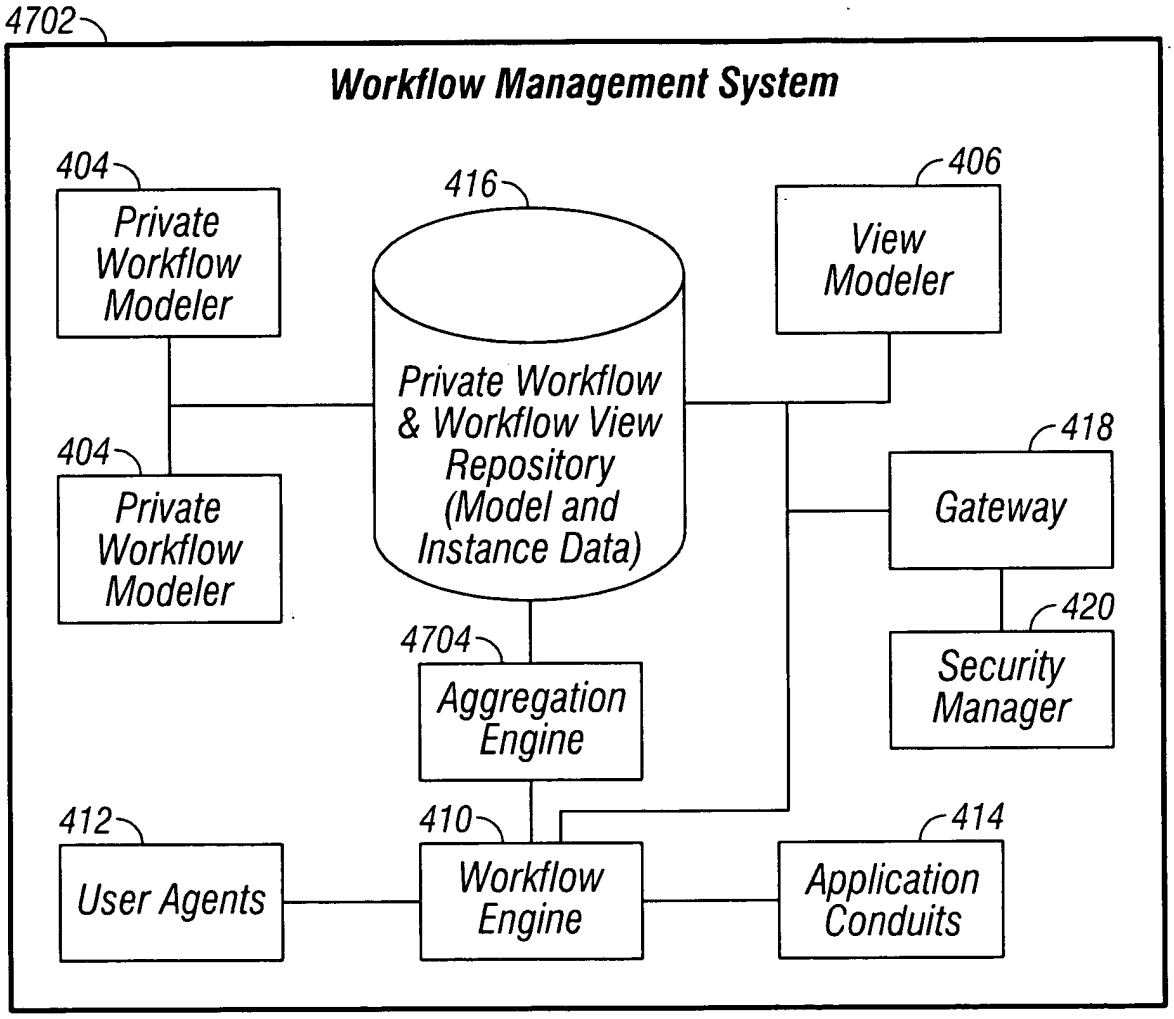
4702
Workflow Management System
404
Private Workflow Modeler
404
Private Workflow Modeler
416
Private Workflow & Workflow View Repository (Model and Instance Data)
406
View Modeler
418
Gateway
420
Security Manager
4704
Aggregation Engine
412
User Agents
410
Workflow Engine
414
Application Conduits

FIG. 47

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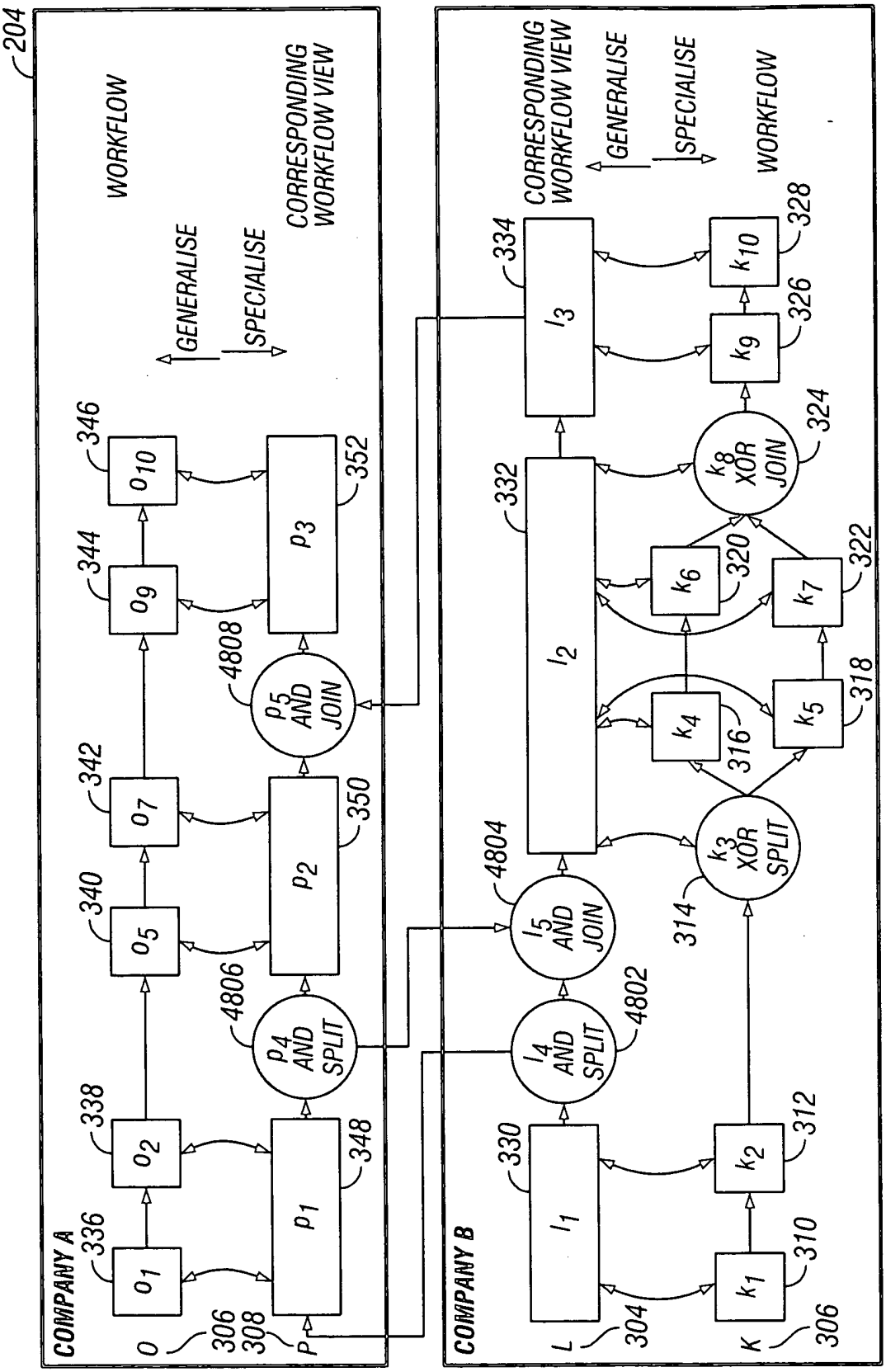
204
COMPANY A
WORKFLOW
GENERALISE
SPECIALISE
CORRESPONDING WORKFLOW VIEW
COMPANY B
CORRESPONDING WORKFLOW VIEW
GENERALISE
SPECIALISE
WORKFLOW
o_1
o_2
o_5
o_7
o_9
o_{10}
p_1
p_2
p_3
p_4 AND SPLIT
p_5 AND JOIN
l_1
l_2
l_3
l_4 AND SPLIT
l_5 AND JOIN
k_1
k_2
k_3 XOR SPLIT
k_4
k_5
k_6
k_7
k_8 XOR JOIN
k_9
k_{10}
O
P
L
K
306
308
304
306
310
312
314
316
318
320
322
324
326
328
330
332
334
336
338
340
342
344
346
348
350
352
4802
4804
4806
4808

FIG. 48

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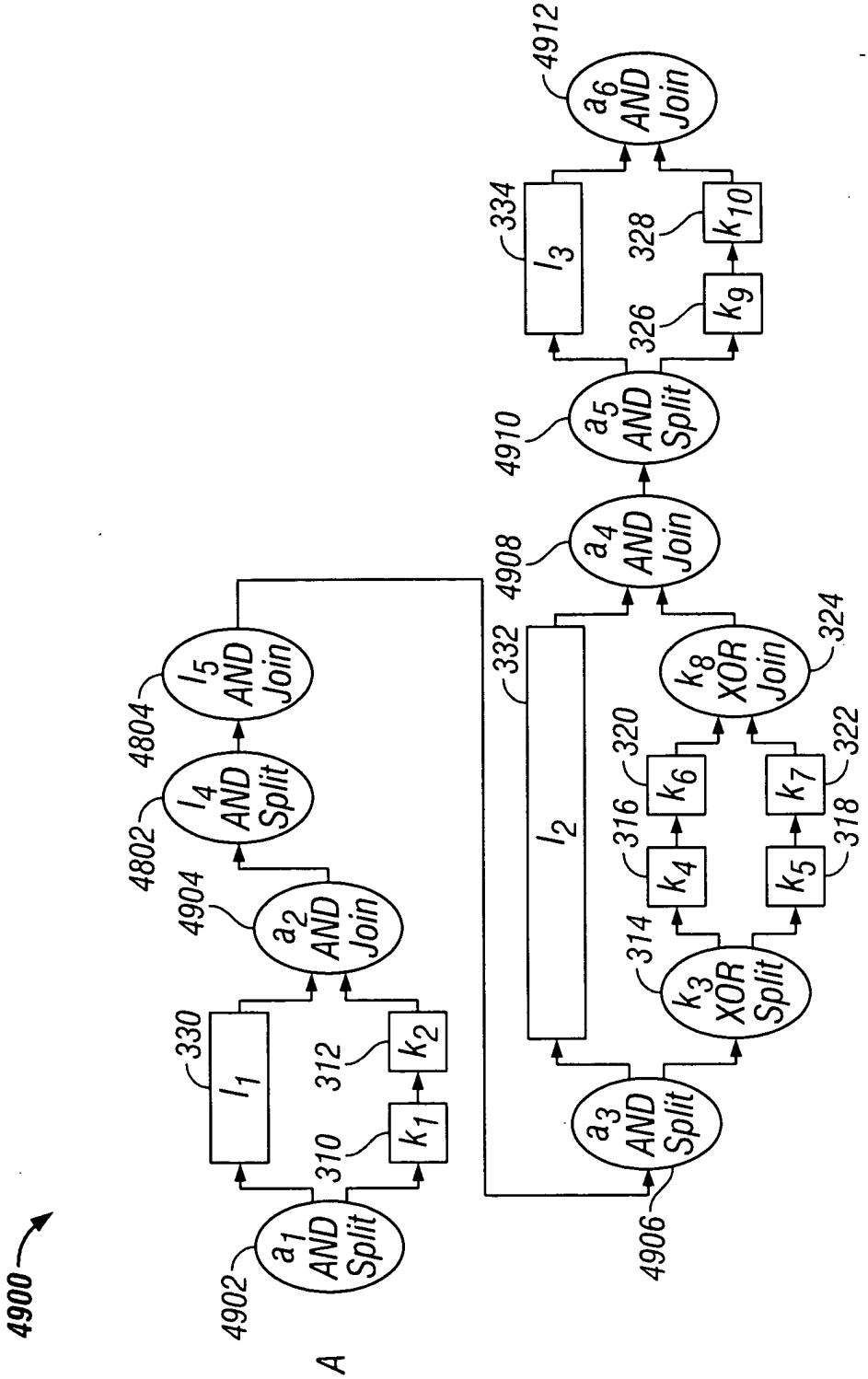
4900
4902
a_1 AND Split
310
k_1
312
k_2
330
l_1
4904
a_2 AND Join
4802
l_4 AND Split
4804
l_5 AND Join
A
4906
a_3 AND Split
314
k_3 XOR Split
316
k_4
318
k_5
320
k_6
322
k_7
324
k_8 XOR Join
332
l_2
4908
a_4 AND Join
4910
a_5 AND Split
326
k_9
328
k_{10}
334
l_3
4912
a_6 AND Join

FIG. 49

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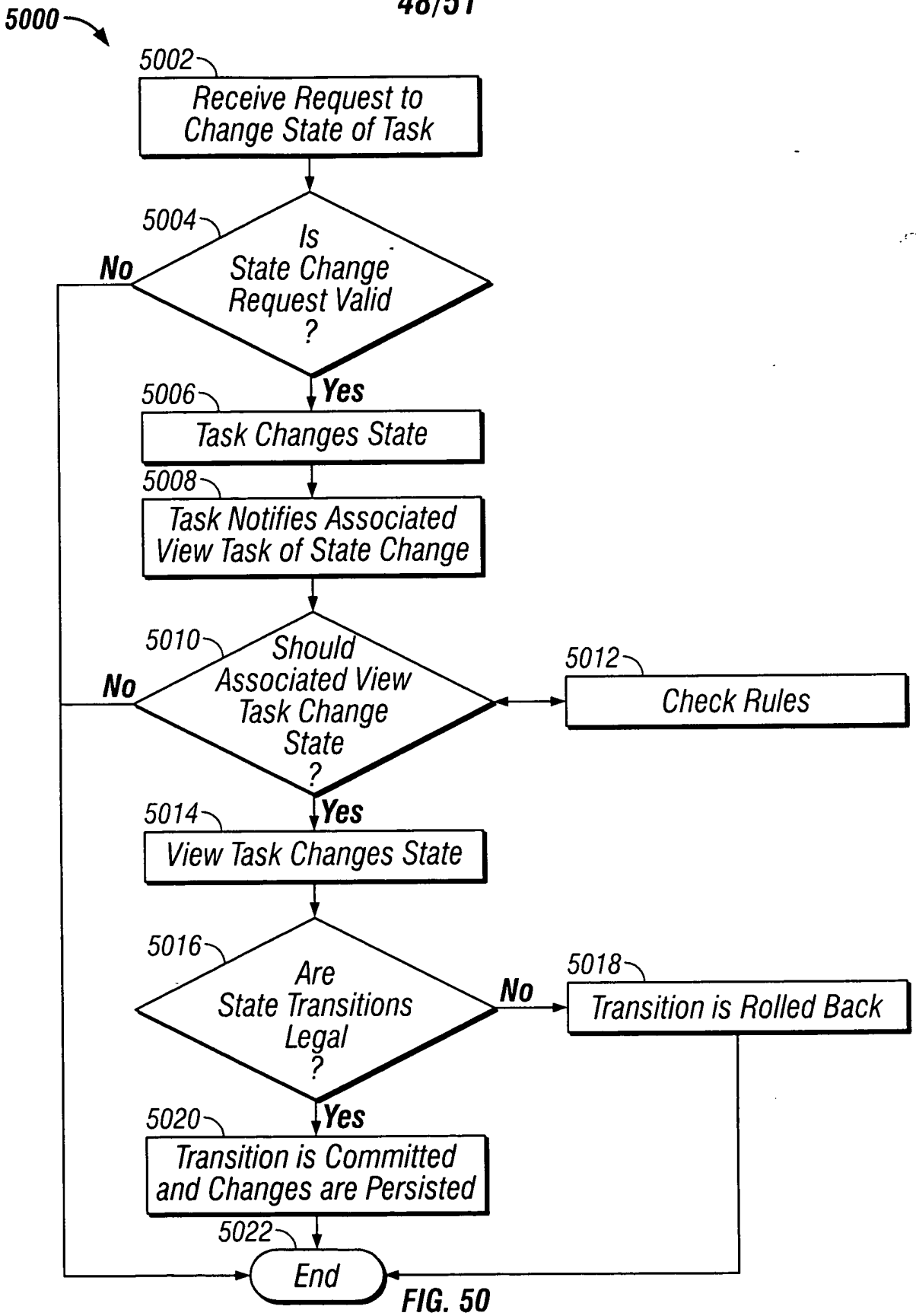
5000
5002
Receive Request to Change State of Task
5004
Is State Change Request Valid ?
No
Yes
5006
Task Changes State
5008
Task Notifies Associated View Task of State Change
5010
Should Associated View Task Change State ?
No
5012
Check Rules
Yes
5014
View Task Changes State
5016
Are State Transitions Legal ?
No
5018
Transition is Rolled Back
Yes
5020
Transition is Committed and Changes are Persisted
5022
End

FIG. 50

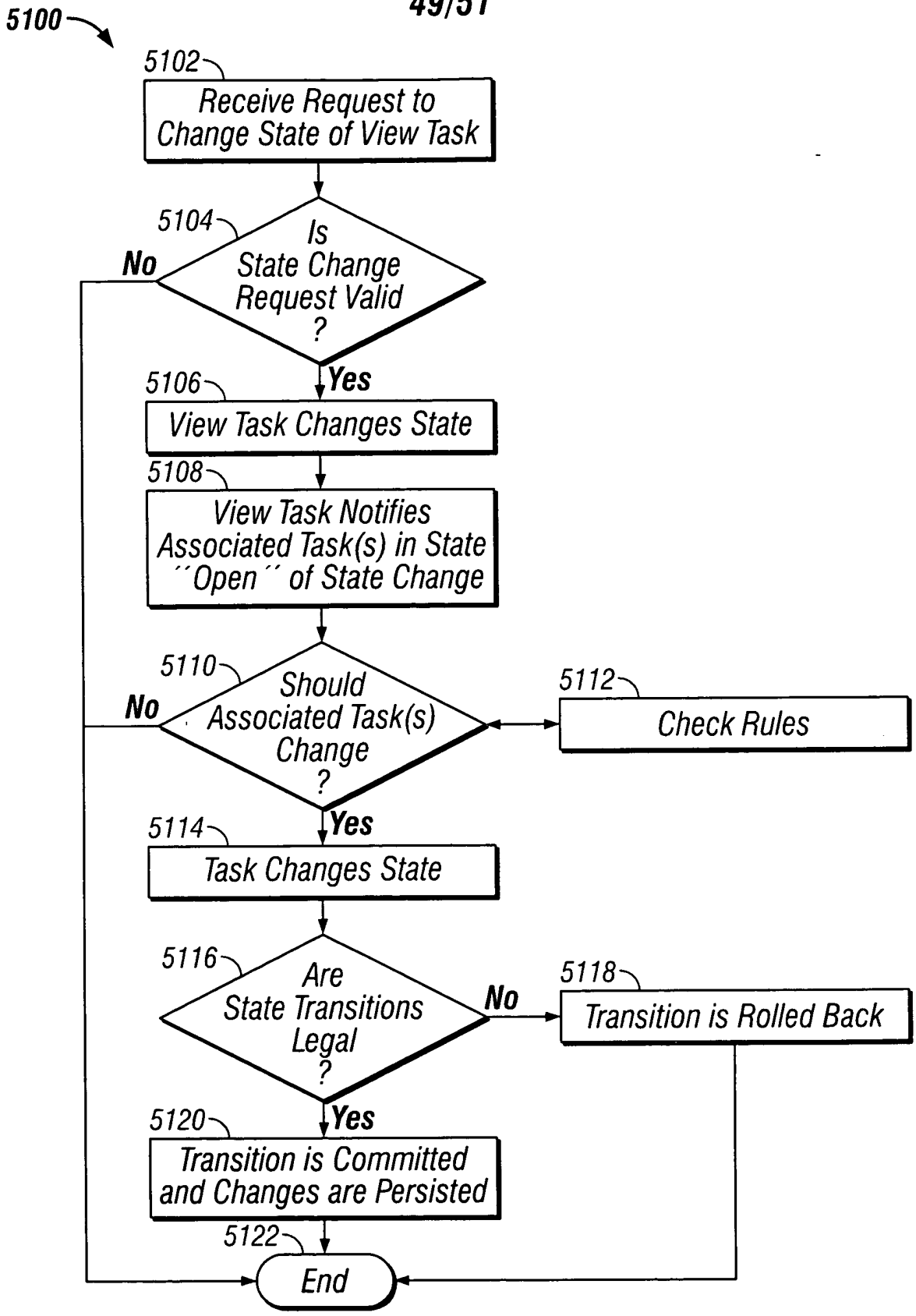
5100
5102
Receive Request to Change State of View Task
5104
Is State Change Request Valid ?
No
Yes
5106
View Task Changes State
5108
View Task Notifies Associated Task(s) in State "Open" of State Change
5110
Should Associated Task(s) Change ?
No
5112
Check Rules
Yes
5114
Task Changes State
5116
Are State Transitions Legal ?
No
5118
Transition is Rolled Back
Yes
5120
Transition is Committed and Changes are Persisted
5122
End

FIG. 51

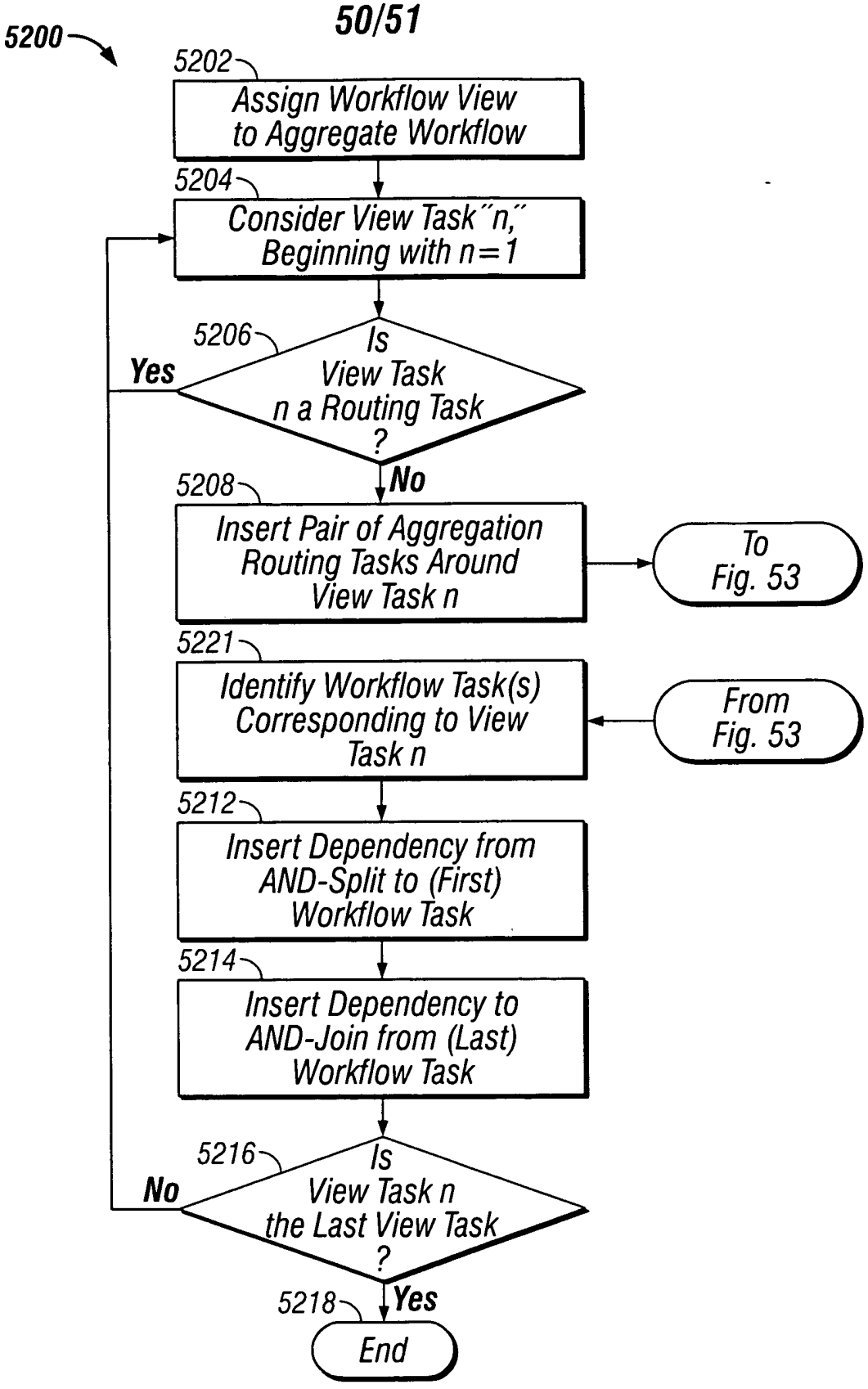
5200
5202
Assign Workflow View to Aggregate Workflow
5204
Consider View Task "n," Beginning with n=1
5206
Is View Task n a Routing Task ?
Yes
No
5208
Insert Pair of Aggregation Routing Tasks Around View Task n
To Fig. 53
5221
Identify Workflow Task(s) Corresponding to View Task n
From Fig. 53
5212
Insert Dependency from AND-Split to (First) Workflow Task
5214
Insert Dependency to AND-Join from (Last) Workflow Task
5216
Is View Task n the Last View Task ?
No
Yes
5218
End

FIG. 52

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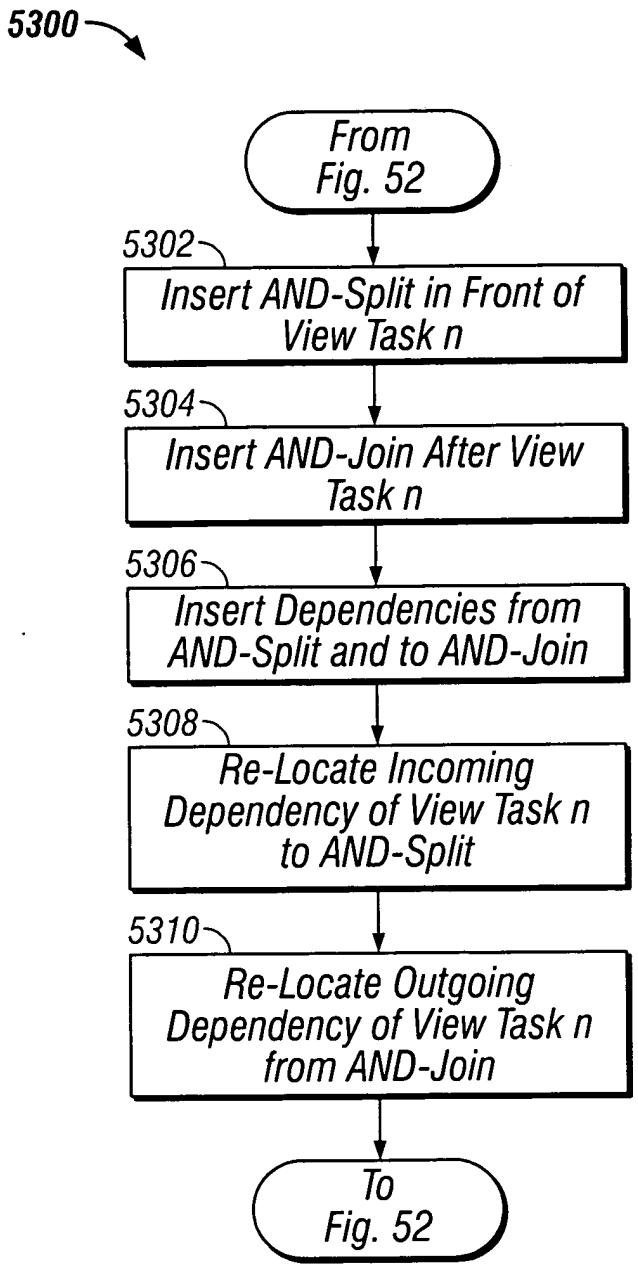
5300
From Fig. 52
5302
Insert AND-Split in Front of View Task n
5304
Insert AND-Join After View Task n
5306
Insert Dependencies from AND-Split and to AND-Join
5308
Re-Locate Incoming Dependency of View Task n to AND-Split
5310
Re-Locate Outgoing Dependency of View Task n from AND-Join
To Fig. 52

FIG. 53